



Fed4QoE - Experimental validation of a QoE analytics framework for LTE and Wi-Fi

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Experiment Description

Background

- ALLBESMART has been developing a QoS/QoE analytics framework (UXPERT) for cellular and Wi-Fi networks.
- UXPROBES automatically execute specific tasks, such as, establishing voice calls, download webpages, access video streaming feeds, etc.
- The UXBRAIN toolset analyses the collected data either in real-time or based on given time-frames.

Experiment Description



Concept and Objectives

- UXPERT is a QoS/QoE analytics framework, for cellular and Wi-Fi networks, composed by radio probes, UXPROBES and a toolset that analyses collected data, UXBRAIN.
- The main goals of this experiment are to calibrate the UXPROBE using state-of-the-art equipment from PerformLTE, to test QoE video analytics over NITOS test network and to showcase and validate UXPERT using a large Wi-Fi deployment on the City Of Things testbed.

Experiment Description

EXPERIMENT SETUP

- Fed4Qoe's experiment has combined 3 Fed4FIRE+ testbeds: Perform LTE, NITOS and City of Things;
- **Phase 1** of execution: In-lab calibration of UXPERT using state-of-the-art measuring equipment from PerformLTE. Four different scenarios were tested:
 - Scenario 1: Ideal-Init 20 @20MHz;
 - Scenario 2: Ideal-Init 20 @5MHz;
 - Scenario 3: Urban Office - Default working conditions;
 - Scenario 4: Urban Pedestrian - City main square;

Experiment Description

- **Phase 2:** Testing UXPERT in a real LTE network under controlled conditions using the NITOS testbed in two different configurations:
 - LTE band 7 with 10MHz bandwidth;
 - LTE band 7 with 5MHz bandwidth.
- **Phase 3:** Showcasing UXPERT using the City of Things Wi-Fi Testbed. Measuring the impact of the Wi-Fi network load and interference on the network performance KPIs.

Project Results

PHASE 1 – PERFORMLTE

Measured Parameter		PerformLTE	UXPERT	error (%)
UE Radio link measurements	RSRP	-	-96.9	-
	RSRQ	-	-5.6	-
	SINR	-	26.6	-
	RSSI	-	-82	-
Ookla speedtest	Downlink bitrate (Mbps)	27.6	28.0	1.4%
	Uplink bitrate (Mbps)	13.0	13.0	0%
	Round trip time (ms)	19	18	3.2%
FAST by Netflix	Downlink bitrate (Mbps)	24.8	25.4	2.3%
Web browsing MOS	www.facebook.com	n/a	4.5	n/a
	www.google.com	n/a	4.5	n/a
	www.youtube.com	n/a	4.4	n/a
	www.allbesmart.pt	n/a	3.4	n/a
	www.fe4fire.eu	n/a	3.6	n/a
Video	Time to start (ms)	n/a	5419	n/a
	Lost frames (%)	n/a	0	n/a

Figure 1: Measurement comparison from Ideal-Init @ 5MHz scenario.



Figure 2: UXPERT integrated in Perform LTE testbed.

Project Results

PHASE 2 - NITOS

VideoUX KPIs (Average values)	
URL	https://youtu.be/OfIQW6s1-ew
Time To Start (video)	3230.25 ms
# stalls (video)	0.03
Stall Duration (video)	1490.7 ms
% Lost Frames (video)	0.03 %
Bitrate (A/V)	16.05 Mbps
% Lost Buffers (audio)	0.01 %
Times Played	364

Figure 3: Video KPIs measured by UXPert over LTE in Band 7 @ 5MHz.



Figure 4: UXPert integrated in NITOS testbed.

Project Results

PHASE 3 – CITY OF THINGS

Nº OF LINKS	MOS	TIME TO START	BITRATE	LOST FRAMES (%)	LOST BUFFERS (%)
1	4.31	3.30 s	1550 Kbps	0	0
2	4.28	5.20 s	1500 Kbps	0	0
3	4.27	5.60 s	1437 Kbps	0	0
4	4.19	7.10 s	1400 Kbps	0.12	0

Figure 5: Impact of Wi-Fi @ 2.4GHz load in the perceived video QoE.

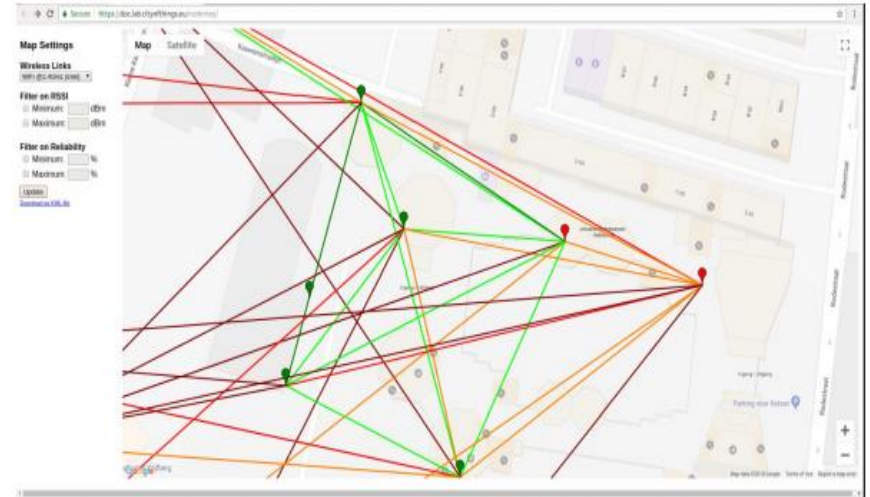


Figure 6: UXPert integrated in City of Things testbed.

Business Impact

VALUE PERCEIVED

- Dense Wi-Fi deployments are a key business area to ALLBESMART. Phase 3 experiment has validated UXPERT as a user QoE benchmark solution in large Wi-Fi deployments.
- Lessons learned will be useful to improve ALLBESMART's Wi-Fi planning with a focus on QoE optimization rather than classical QoS approaches.

Business Impact



VALUE PERCEIVED

- Exhaustive testing of the UXPERT video QoE tool over commercial LTE networks is expensive in terms of data quota and many times limited to fair use policy. NITOS testbed doesn't suffer from this limitation which is important for validating our video QoE estimation algorithms implemented in UXPERT.
- Since ALLBESMART doesn't have access to the range of LTE network equipment and system emulator, this experiment was a crucial step in our UXPERT product development process.

Business Impact



VALUE PERCEIVED

- This experiment has enabled us to speed up our UXPERT prototype demonstration in operational environment (TRL7), complete it and qualify it for commercial adoption (TRL8).
- This is an important step towards the certification of UXPERT as a framework ready to be adopted by Mobile Network Operators (MNOs).
- The experiment's results were an important showcase to promote the UXPERT framework as a state-of-the-art product for network performance analytics.

FEEDBACK



RESOURCES AND TOOLS USED

- Perform LTE (UMA) was used to calibrate the UXPROBE and QoE analytics tools through benchmarking against professional in-lab LTE test equipment. The DC power analyser was used to characterize the power consumption of UXPROBE.
- NITOS (UTH) was used to validate the UXPERT framework for video QoE analysis in a controlled LTE network, without the need of commercial SIM cards and data quota limitations.

FEEDBACK



RESOURCES AND TOOLS USED

- City Of Things (imec) was used to showcase UXBRAIN in a real environment and to analyse the impact of power and channel allocation strategies on different applications. Testing in a realistic high interference environment with 5 nodes.
- jFed was used for node scheduling and activation/maintenance of the experiments.

FEEDBACK



SUGGESTIONS

- PERFORMLTE: VoLTE capability would be a great addition to the testbed;
- NITOS: The EPC needs to be updated to be compliant with more recent LTE modems;
- City of Things: Provide more Wi-Fi nodes with line-of-sight, higher node density.

FEEDBACK

ADDED VALUE

- Possibility to combine experiments from heterogeneous infrastructures and network technologies.
- Possibility to run end-to-end experimentation (RAN+Core).
- Easy setup of experiments



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