



XMobiSensePlus: An updated application for the assessment of Human exposure to RF-EMFs

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Outline

- Context and Objective
- Methods
- Results
- Conclusion and Future works



Context and Objective

Context (1/2)

- Ubiquitous wireless communications lead to a public concern about the human exposure to radio frequency electromagnetic fields (RF-EMFs).
- The human exposure may depends on
 - The network technology (e.g., 2G, 3G, 4G)
 - The usage (e.g., data, voice)
- Such dependency is due to the fact that the power of emitted signals by either the base station or the user equipment may change according to the implemented protocols.

Context (2/2)

- Calling via Voice over IP (VoIP) using apps such as Skype, Viber and WhatsApp is common nowadays, but in traffic records, these calls are included with all the other data transfers.
- VoIP calls may lead to different exposure levels for people than other data usage since the position in which the phone is held could be different than for other data usage such as web surfing.

Objective

■ Objective

- Aid evaluation of human exposure to RF-EMFs in epidemiological studies.
- Carry on measurement campaigns with volunteers.

■ Challenge

- Commercial drive test solutions are not used in measurement campaigns with volunteers because they are very expensive.

■ Solution

- Developing and updating an Android application, which could be installed on numerous and various mobile phones of volunteers.
- Telecom ParisTech has modified and updated the ***XMobiSense*** app, previously used in several epidemiological settings, into ***XMobiSensePlus*** in order to adapt to the stunningly rapid evolution of the Android operating system.



Methods

XMobiSensePlus

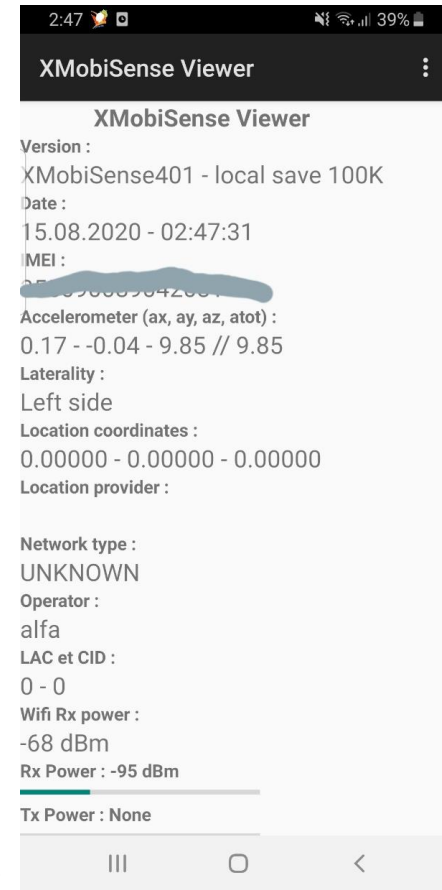
- **XMobiSensePlus** is an Android application, which allows collecting data from volunteers in their daily life.
- The purpose of XMobiSensePlus is to contribute to epidemiological studies through providing researchers with parameters crucial for the assessment of the human exposure to RF-EMFs.



The logo of XMobiSense/Plus

Data recordings

- XMobiSensePlus records data continuously, every second when telecom activity is occurring and every 2 minutes otherwise.
- It allows recording in Log files (of 100 Kbytes):
 - The state of the phone (e.g., An incoming/outgoing voice call; On/Off WiFi connection; On/Off mobile data)
 - The received power levels
 - The GPS data
 - The use of headsets and the loudspeaker
 - The values of the accelerometers and the proximity sensor, both used to predict the laterality of the mobile phone with respect to the head or body during calls.



Old app issues

- With the rapid evolvement of Android operating system, XMobiSense starts to present some issues:
 - A sudden shutdown of the XMobiSense app.
 - An invalid measurement of the received power, especially for 4G.

Sudden shutdown: issue and solution

Issue

- Due to the power saving features of the evolved Android versions, the XMobiSense app will shutdown when it was running on **background** mode and the device is not used for a long period. Hence the recording of information will stop.

Solution

- XMobiSensePlus implemented a **foreground** service with a permanent notification, indicating the normal running of the app.

Invalid received power: issue and solution

Issue

- The old version of the app provides a unique measure of the received power, which is invalid for certain radio cells.

Solution

- The recent Android versions provide different measures of the received power, according to the radio technology.
 - i. The received signal strength indicator (RSSI) for WiFi, GSM (2G) or CDMA cells
 - ii. The reference signal received power (RSRP) for LTE (4G) cells
 - iii. The received signal code power (RSCP) for WCDMA (3G) cells
- The raw data about these various received power levels requires further analysis during post-processing.

Description of measurement campaigns

- XMobiSensePlus was installed on 10 different smartphones, and tested in the Lyon area for a period of at least 1 month (extending from Dec 2019 till Feb 2020).
- Test calls in various circumstances
 - Calls made with the phone held to the head, calls made using headsets, the phone speaker or the video,
 - Calls made inside and outside buildings in several micro-environments,
 - VoIP calls made using Skype, Viber and WhatsApp using the operators networks or the WiFi networks.
- The accuracy of XMobiSensePlus is determined by comparing the detailed diary (produced by the investigator) with the log files.



Results

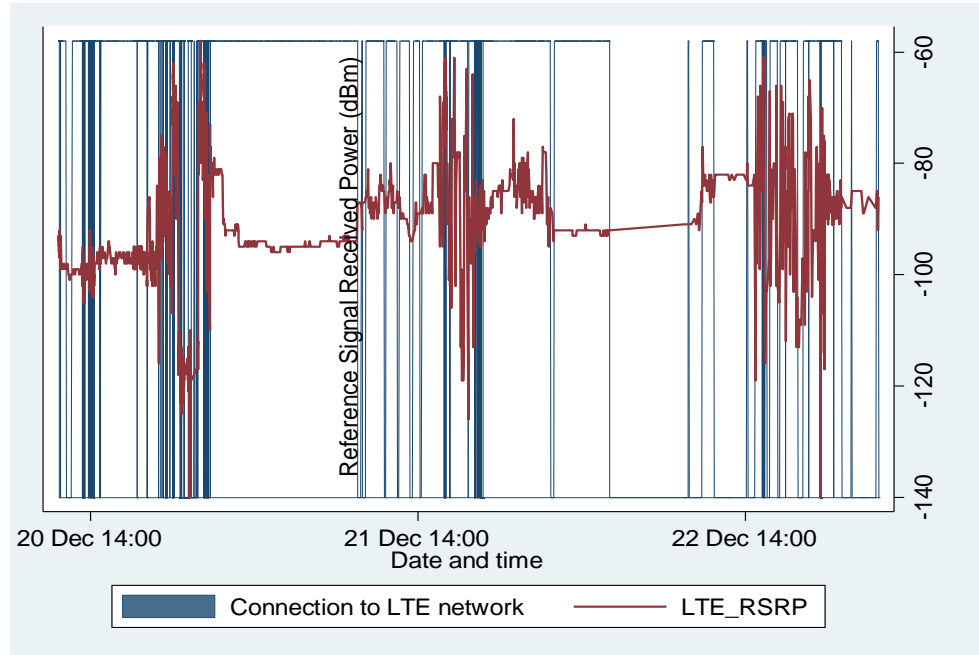
Results

- Data collection is ongoing.
- Preliminary results demonstrate that the new version of the XMobiSensePlus app is stable, and records data continuously, as long as the user does not stop the app willingly.
- The recording of headsets was accurate.

Results:

Variation of RSRP levels over 3 days period

- The blue background indicates whether the mobile phone is connected to an LTE cell.
- When the user is not moving, e.g. at the night, the levels of the RSRPs are almost constant.
- The RSRP levels change with motion, specifically with the relative position to the connected cell.





Conclusion and Future works

Conclusion

- XMobiSensePlus is an Android app that contributes in the assessment of human exposure to RF-EMFs through the collection of adequate information.
- The updates of the old version address the issues related to the sudden shutdown and the invalid measurement of received powers.
- Preliminary results show that
 - The App is stable and can be installed on different types of Android phones.
 - It records a wealth of information on the phone's telecom traffic and can therefore be used in some epidemiological studies, such as the Coriolis epidemiological study whose purpose is to assess the level of exposure to RF-EMFs associated to mobile telephony in France.

Future works

- The performance of the app in recording all the parameters.
- Post-processing of the raw received powers in order to get a unique RSSI.
- The development of an algorithm to distinguish VoIP calls from other data transfers based on the XMobiSensePlus App logs.



Thank you