URSI GASS 2020, Rome, Italy, 29 August - 5 September 2020

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

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Abstract

Calling via Voice over IP 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. Voice over IP 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. Telecom ParisTech has modified the XMobiSense app, previously used in several epidemiological settings, to record details of data transfers. The app updates are crucial in order to adapt to the stunningly rapid evolution of the Android operating system.

1 Introduction

XMobiSense is an Android application (app) whose main purpose is to aid evaluation of human exposure to radio frequency electromagnetic fields (RF-EMFs) in epidemiological studies [1]. This app has been developed in order to be installed on numerous and various mobile phones for measurement campaigns of determinants of the users' exposures. The development of XMobiSense has permitted to collect data of 466 volunteers from 12 countries in their daily life [1]. Indeed the commercial drive test solutions such as Nemo Handy (from Keysight Technologies) are very expensive, it is therefore nearly impossible to use these routines in measurement campaigns with volunteers.

The XMobiSense app was originally developed by Telecom ParisTech in collaboration with Orange Labs. With the stunningly rapid evolution of the Android operating system, XMobiSense functionalities have recently been extended thanks to a collaboration between Telecom ParisTech and the University of Balamand. The new version, called XMobiSensePlus, was required in order to (1) maintain the XMobiSense app and/or adapt it to the evolutions of the Android systems, and (2) allow the recording of additional information. XMobiSensePlus allows now the recording of data transfers and connection of the phone to WiFi networks, level of received power from mobile and WiFi networks, and geolocalisation of the user in the Global Positioning System (GPS), in addition to the details of voice calls, use of headsets and loudspeaker, and some information related to the position in which the phone is held (i.e. laterality of the phone when it is held to the head).

Voice calls and data transfer need to be recorded separately for epidemiological studies, because they lead to different levels of exposures of different body parts. However, Voice over IP (VoIP) calls remain challenging: they may lead to different exposures than other data transfers since the phone might be held close to the head, while this may not be the case for other data transfers; in addition, VoIP calls made over the WiFi networks do not appear in operators' traffic records [2].

2 Methods

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. Once installed, the new version records the state of the phone: it checks if a voice call is ongoing, it identifies if a WiFi connection is on and if a data transfer activity is occurring through the mobile or the WiFi network. It also records 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.

Starting from Android 6.0, Android has introduced power saving features that extend battery life for users by managing the running apps. These recent Android versions will shut certain apps down when the device is not used for a long period. This resulted in the shutdown of the XMobiSense app when it was running on background mode and hence the recording of information was stopped. In order to overcome this issue, XMobiSensePlus implemented a foreground service with a permanent notification, indicating the normal running of the app. It records data continuously, every second when telecom activity is occurring and every 2 minutes otherwise. This new implementation of XMobiSensePlus reduces the use of the battery.

One of the crucial parameters in the RF-EMFs exposure assessment is the received power levels from Down-Link communication. The recent Android versions do not provide a unique measure of the received power, because it changes according to the radio technology. Indeed, the Android system permits recording of i) the reference signal received power (RSSI) if the mobile phone is using WiFi, Global System for Mobile communications (GSM) or Code Division Multiple Access (CDMA) cell, ii) the reference signal received power (RSRP) if the connected cell is a Long Term Evolution (LTE) cell and iii) the received signal code power (RSCP) if the connected cell is a Wide Code Division Multiple Access (WCDMA) cell. The raw data about these various received power levels require further analysis during post-processing.

For testing the functioning of the new app, XMobiSensePlus was installed on 10 different smartphones, with the 4 mobile network operators of France, and tested in the Lyon area for a period of at least 1 month (extending from Dec 2019 till Feb 2020). With some phones, test calls in various circumstances were made by the investigator, according to a protocol. Specifically, we considered 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, calls made using Skype, Viber and WhatsApp using the operators networks or the WiFi networks. For other phones, the investigator produced a detailed diary of the usual telecom traffic of the phone, by checking the phones logs, including calls and VoIP calls using Skype, Viber and WhatsApp. The protocol and the call diary were compared with the logs of XMobiSensePlus for accuracy.

3 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. Fig. 1 shows the variation of the RSRP levels over 3 days period in Lyon, France. 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. However, these levels change with motion, specifically with the relative position to the connected cell. The performance of the app in recording the other parameters will be further investigated in future work.

4 Conclusion

XMobiSensePlus app allows the collection of information similar to operator traffic records data directly from the users' phone. Preliminary results show that the App is stable and can be installed on different types of Android phones. XMobiSensePlus records a wealth of information on the phone's telecom traffic and can therefore be used in some epidemiological setting, such as the Coriolis epidemiological study (not addressed in this paper) whose purpose is to assess the level of exposure to RF-EMFs associated to mobile telephony in France.
Since the RF-EMF exposure might differ between calls, VoIP calls and data transfers, an option is to develop an algorithm to distinguish Voice over IP calls from other data transfers based on the XMobiSensePlus App logs. We will investigate the performance of such algorithm in controlled test datasets in future work.

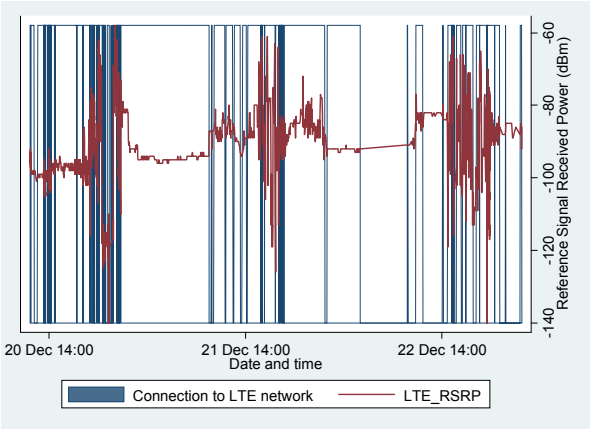

Figure 1. Reference Signal Received Power levels (red line) during the connections to LTE network (blue background) over 3-days period, Lyon, France.

5 Acknowledgements

The authors would like to thank the French National Research Program for Environmental and Occupational Health of ANSES with the support of the Cancer TMOI of the French National Alliance for Life and Health Sciences (AVIESAN) for the CORIOLIS project (EST/2017/2 RF/15).

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