

# Reducing exposure to radiofrequency electromagnetic fields from wireless networking with laptop computers

Tarmo Koppel, Mikko Ahonen<sup>2</sup>, Inese Vilcane<sup>3</sup>

<sup>1</sup> Tallinn University of Technology, Estonia, tarmo.koppel@ttu.ee

<sup>2</sup> University of Tampere, Finland, mikko.p.ahonen@uta.fi

<sup>3</sup> Riga Technical University, Latvia, inese.vilcane@rtu.lv

## Abstract

Mobile modems are used with laptops to connect Internet wirelessly. Recently several organisations, including the WHO IARC and the European Union have emphasised health risk-management practices related to wireless devices. We present here radio frequency (RF) power density measurements when a wireless modem is 30 cm, 1 m and 5 m from a user. Our results indicate that by using a USB cable and adding distance between a user and a wireless modem, there is a substantial reduction of exposure. Additionally we noticed a great difference in GSM/EDGE versus 3G/HSDPA radiation power density levels. Therefore, precautionary principle and USB-cable related risk-management practise is recommended when utilising wireless modems with laptops.

*Keywords:* mobile modem, radiofrequency, radiation, laptop, exposure.

## Introduction

Soft tissues of stomach and genitals absorb more radiofrequency radiation, measured by SAR (Specific Absorption Rate). Similarly, fertility may be affected by close radiofrequency (RF) exposure by pulsed microwave technologies (Adams *et al.* 2014, Avendano *et al.* 2012), while harmful effects seem to require a longer exposure time (Poullietier de Gannes *et al.* 2013). The European Union (2009) has recommended minimising RF exposure and educating users of safer ways of using mobile devices. In 2011 the WHO IARC classified radiofrequency radiation (and microwave radiation) “possibly carcinogenic” (IARC, 2011). Simultaneously, the short-term thermal effects focused RF-guidelines (ICNIRP, 1998) are not exceeded by radiation levels produced by wireless modems. Laptop manufacturers state in their manuals: “*Usage precautions during 3G connection : Keep safe distance from pregnant women’s stomach or from lower stomach of teenagers*” (Samsung, 2013). Similarly, tablet manufacturers recommend: “*.. limit your exposure by limiting the amount of time using iPad Wi-Fi + 3G in wireless mode, since time is a factor in how much exposure a person receives, and by placing more distance between your body and iPad Wi-Fi + 3G, since exposure level drops off dramatically with distance.*” (Apple, 2013). In this research paper we focus on laptops since tablet computers do not always include a possibility to attach an external wireless modem with a USB cable. Earlier we have inspected Wi-Fi routers, Wi-Fi antennas and related risk-management for mobile learning (Ahonen and Koppel, 2012). Similarly, we have inspected effects of various shielding materials (Koppel and Ahonen, 2014). In this paper the focus is on distance and how much radiofrequency radiation attenuates, when a wireless modem is brought away from a laptop and its user.

## Methodology of Research

Several wireless modems (by Huawei, ZTE) were attached to laptop computers and then measured inside buildings. Measurements were done in Tampere (Finland) and in Tallinn (Estonia). The measurement instruments were radiation frequency power density meters (Gigahertz Solutions HF 59B). These analysers measure pulsed radiofrequency radiation (RF) in scale 800MHz-2500MHz with a directional antenna. First, a mobile broadband modem (a stick) was directly attached to the USB-slot of a laptop and the measurement was taken 30 cm from this modem, in a place where the fictive user was sitting. Then, a USB-cable was attached to the computer and the mobile modem was attached to end of this cable. This way the measurements could also be performed from 1 m, 2 m, 5 m distance from the laptop (user) to the wireless modem, even when the mobile modem was brought outside of the house, out of the window. This set-up simultaneously allowed adding distance between the laptop user and the wireless modem. During these measurements the wireless modem was set to upload-mode, to maximise data-transfer rate and microwave exposure. Two data transfer protocols were tested, namely 3G/HSDPA and GSM/EDGE.

## Findings/Results

Substantial decrease in microwave power density levels were observed, when distance was added between the laptop (user) and the wireless modem (USB-stick). The next table shows the effect of distance in relation to radiofrequency (microwave) radiation exposure.

**Table 1.** Radiofrequency radiation exposure from the wireless modem, average (RMS) + peak values. An example of a measurement of one particular USB-modem.

Distance to modem	Power density mW/m <sup>2</sup> RMS (Peak)	Power density mW/m <sup>2</sup> RMS (Peak)
	3G / HSDPA	GSM / EDGE
30 cm	0,31 (16,5)	33 (325)
1 meter	0,07 (0,45)	11 (120)
5 meters	0,01 (0,13)	2,5 (5)
outside the building	0,003 (0,05)	0,1 (3,7)

Generally, the results showed a great reduction when the distance was added. The power density levels of 3G / HSDPA were several times lower than power density levels of GSM / EDGE. Very close to the wireless modem (30 cm) the used antenna type (UBB-27) may not be optimal for measurements and more measurements are being done. The readings in the example measurement were taken in under good coverage situation (almost an eye-sight to the base station which was 600 meters from the measured house). If measurements are done in a bad coverage situation, the measured values can be several times higher. The achieved level, especially with 5 meter additional distance, was below the recommendation of the Council of Europe (2011) which is  $< 0,1 \text{ mW/m}^2$  ( $< 0,2 \text{ V/m}$ ).

## Conclusions

Based on our measurements, we recommend using wireless broadband modems connected to laptops with longer USB-cables. This is an effective way of controlling possible health risks related to RF-technologies. Tablet computer technologies would also benefit from this kind of risk-management.

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