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ASSESMENT OF THE URBAN ELECTROMAGNETIC ENVIRONMENT FOR HOME TELEMEDICINE

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Abstract: The explosion of new sources has created unprecedented levels of electromagnetic fields that now cover all but remote areas of the habitable space on earth with low intensity and long time exposures.
This paper intends to address the electromagnetic environment actually present in wich medical devices operate in urban homes, with respect to the assessment for potential safe use of home telemedicine systems, as there is growing interest on implementing these systems for home care applications such as chronic patients and elderly care.
Data is scarce on electromagnetic radiation in the home environment. The goal should be ElectroMagnetic Compatibility (EMC), making sure that that a product operate operates in its intended environment without being affected by other electronic products or being a source of interference itself. Discussing the unprecedented changes in medicine technologies as well as new wireless-frequencies management, services and technologies.

I. INTRODUCTION

This research intends to address the characterizing of electromagnetic environments actually present in urban homes with respect to the assessment for potential safe use of home telemedicine systems [1]. The background level of ElectroMagnetic Fields (EMF) from electrical sources has risen exponentiallly, most reciently by the soaring popularity of wireless technologies such as cell phones, cordless phones, Wi-Fi and Wi-Max networks. The explosion of new sources has created unprecedented levels of electromagnetic fields that now cover all but remote areas of the habitable space on earth with exposures to low level, low intensity and intermittent sources of RF radiation. Wireless technology is changing rapidly in both exposure characteristics (e.g., frequencies and modulation) and usage pattern (e.g., phone use vs. text messaging or web surfing) and is leading to devices such as wireless PCs, handheld devices used for video calls, and other handheld devices for test messaging. In their typical usage, the antennas are closer to the hand or other parts of the body.
This paper discuss about the key to addressing Electromagnetic Interference (EMI) by means of the recognition, that involves not only the devices itself but also the environment in which it is used, and anything that may come into that environment. Several factors are making compatibility difficult, these include proliferation of new devices, mobility, the trend to digital and the reliance on weak signals. Discussing the unprecedented changes in medicine technologies as well as new wireless-frequencies management, services and technologies.
“Nomadic technologies” that help to free up our everyday lives for example microwave cookers, mobile phones, remote controls etc tend to utilize unlicensed frequency bands were the resulting Electromagnetic interference (EMI) can have an effect on any electronic device. The result with a medical device would not only be an inconvenience but also it could potentially be life-threatening. Particularly as these telemetry systems will have to coexist in the same electromagnetic environment as a large number of other wireless links. In the current standards, are not accounted conditions regarding human exposure and long-term and low-intensity effects and Medical Devices Electromagnetic Compatibility (EMC).
These standards also do not cover the emerging home telemedicine scenarios. Furthermore, data is scarce on electromagnetic radiation in the home environment with regard to issues of telemedicine electromagnetic compatibility.
One emerging approach to improving the wear ability of continuous ambulatory monitoring systems is to improve body-attached sensors with built-in wireless telemetry. Thus freeing the user from having to carry a data recorder. For these telemetry systems, it is probably that a large number of wireless links coexist

in the same area sharing the electromagnetic environment. There is negligible or relatively littles knowledge of local sources of RF radiation on close proximity to metallic implants, external or implanted medical devices.

On the other hand, because of the wide proliferation of wireless communication systems, and other RF radiation systems, there is an increasing public concern of the potential effects of extended exposure to electromagnetic radiation [2], [3].

Prior to the rapid development of wireless communications for personal and business usage, microwave frequencies used for wireless communications were negligible. Nowadays, wireless voice and communications have introduced unprecedented sources of public exposure in the last decade. This workgroup have measured and is measuring yet and reporting common sources and levels of RF in the environment, the invironment in which devices are used and in multiple frequencies exposures.

II. MATERIAL AND METHODS

International guidelines for limiting exposure to electromagnetic fields in the frequency range 100 KHz to 300GHz have been published. These are intended to provide a safe, healthy working or living environment from exposure to radiofrequency fields under all normal conditions. Literature is scarce on data for measured EM environments in home sites and telemedicine EMC issues.

There are a number of standards to cope with human exposure, for Medical Devices Electromagnetic Compatibility (EMC) and Radio communications equipments EMC. However, these standards do not cover the emerging home telemedicine scenarios. Furthermore, literature is scarce on data for measured EM environments in home sites and telemedicine EMC issues.

Practical measurements had been performed at 46 sites in Madrid between 2003 and 2004 in accordance with ICNIRP-98 standard. This research addressed the characterizing of EM environments actually present in urban homes regarding the assessment for potential safe use of home telemedicine systems. The data had been analyzed with regard to potential risks and operational disturbances in accordance with existing European standards.

Fig.1. RADMAN XT ESM-30 Radiation Monitor

It was used a battery powered, portable ESM-30 “RadMan XT” Radiation Monitor (Narda Safety Test Solutions GmbH) that automatically measure and record data on site (See Figure 1). This device measures according to the standard ICNIRP-98 in broad band and the E-field and H-field is expressed as percentages of the standard limit values, as can be seen in Figure 2 in range 1 MHz - 40 GHz.

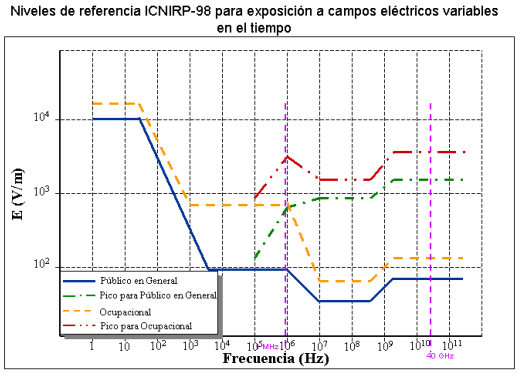

Fig 2. E field reference level ICNIRP-98 and frequency band of RadMan

Results from these studies of EM levels at home sites in Madrid revealed that baseline levels are safe in accordance to with current standard (ICNIRP-98). These levels seemed to be quite stable with time and irrespective of the location in the city

II.1 Measuring Method

This communication describes characterizing of EM environments actually present in urban homes regarding the assessment for potential safe use of home telemedicine systems. Actual EM field levels have been measured with a portable device ANTENNESSA EME SPY 120. It is a selective, isotropic personal exposure meter that has been designed for epidemiological studies. It can measure 12 frequency bands (FM, TV3, TETRA, TV4&5, GSM Rx&Tx, DCS Rx&Tx, DECT, UMTS Rx&Tx, Wi-Fi) and identify the contribution of each emitter.

It was used a battery powered, portable (195 mm x 95.4 mm x 75 mm) and 450g that automatically measure and record data on site (See Figure 3) and in Figure 4 is shown its frequency range: 88MHz – 2,5 GHz.

Fig 3. ANTENNESSA EME SPY 120

This equipment perform 7168 measures MAX over .

the 12 frequency ranges, e.g. 84000 samples. The SPY Analysis software allows configuring a recording period between 4 s and 255 s and a duration of the recording minimum of 1 mn and maximum that depends of the chosen recording period and the maximum number of measurements. The lower detection limit is 0,05 volt per meter (V/m) and the upper detection limit is 5 V/m.

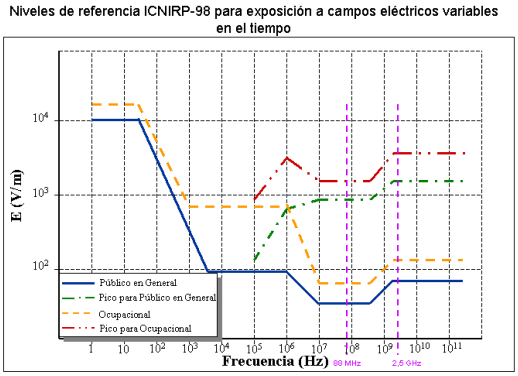

Fig.4. E field reference level ICNIRP-98 and frequency band of SPY

The monitoring chart shows the evolution in time of the field for the different frequency ranges. Main domestic Radiofrequency emitters and their radiation characteristics were observed. Home environments exposure conditions tend to be considered uncontrolled as opposed to the controlled exposure conditions (hospital or office work environment).

II.2 Data Analysis

The data is displayed by default in $V.m^{-1}$ or can be displayed in $\mu W.m^{-1}$ or in % compared with the ICNIRP standards. The data has been analyzed with regard to potential risks and operational disturbances in accordance with existing European standards.
It were observed the main domestic Radiofrequency emitters and their radiation levels in the 12 different frequency ranges.

Table I - Communication Services and working frequencies

Communication services	Frequency bands
FM	88-108 MHz
TV3	174-223 MHz
TETRA	380-400 MHz
TV4&5	470-830 MHz
GSM Rx	880-915 MHz
GSM Tx	925-960 MHz
DCS Rx	1710-1785 MHz
DCS Tx	1805-1880 MHz
DECT	1880-1900 MHz
UMTS Rx	1920-1980 MHz
UMTS Tx	2110-2170 MHz
Wi-Fi	2400-2500 MHz

III. RESULTS

Preliminary results from these studies of electromagnetic levels reveals that baseline levels are within the safety margin in accordance with the current standard ICNIRP-98 [4].
The records of the measured home environmental E fields showed a low level stable base line over which it appears isolated peaks or bursts that in some frequency bands are quite high. Figure 3 shows an example of E field level measured at site A620. Both indoor and outdoor ambient RF power density measurements showed high variability depending on proximity to transmitting antennas.

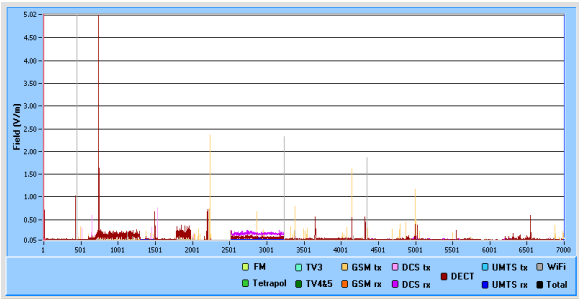

Fig. 5 – Example of E field level measured at site # A620

In Figure 5 is showed an example of radiation levels in the 12 different frequency ranges and the main contribution in the Wi-Fi band, with a level of 5.02 V/m, in the DECT band with a level of 5.02 V/m and in the GSM tx band with a level of 2.36 V/m. In Table II are shown E field levels of some services and reference level in medical electrical equipment standard.

Table II - E Field level of some services and reference level of the Medical electrical equipment standard

Service	Freq. band (MHz)	E (V/m)	Ref level IEC EN 60601-1-2 (V/m)	ICNIRP (%)
Wi-Fi	2400-2500	5.02	3	68
DECT	1880-1900	5.02	3	71
GSM tx	925-960	2.36	3	34

The presence of relative high peaks or burst of radiated signals in the proximity of household equipment such as, wireless telephone, microwaveovens, GSM telephone, etc, may be compared with standard radiated emission tests for civilian electronic systems [5], [6].

The next Figure 6, Figure 7 and Figure 8 show E maximun level in Wi-Fi, DECT and GSM tx frequency bands.

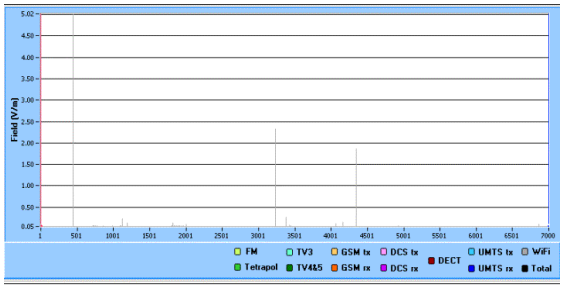

Fig. 6 – E level in Wi-Fi band measured at site # A620

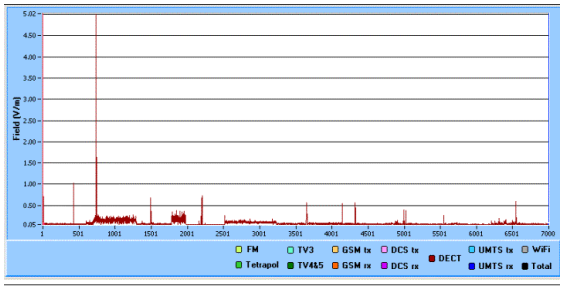

Fig. 7 – E level in DECT band measured at site # A620

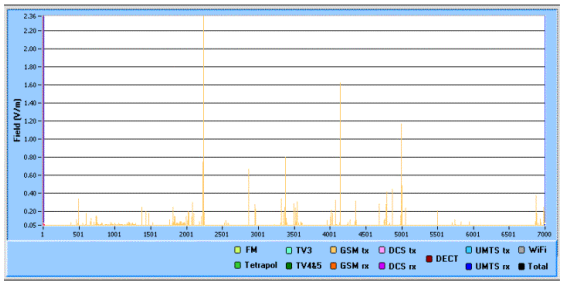

Fig. 8– E level in GSM tx band measured at site # A620

These levels seem to be quite stable with time and irrespective of the location in the city.

Data can be displaying in % compared with the ICNIRP standard, that is shown in next Figure 9, Figure 10 and Figure 11.

It would make necessary a local assessment and risk analysis prior to the installation of a home telemedicine application.

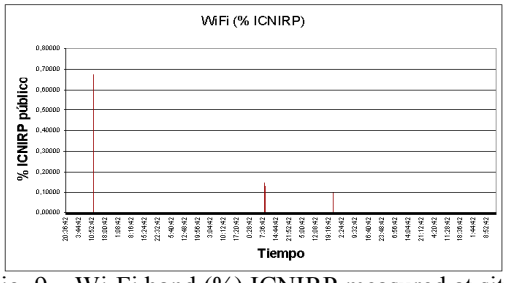

Fig. 9 – Wi-Fi band (%) ICNIRP measured at site # A620

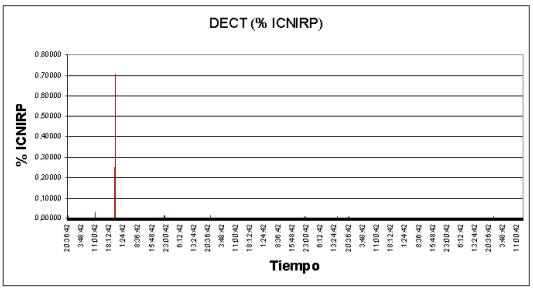

Fig. 10 – DECT band (%) ICNIRP measured at site # A620

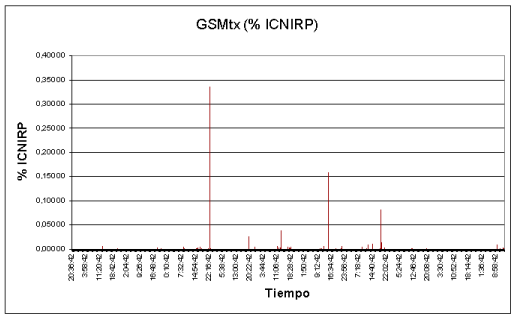

Fig. 11– GSM tx band (%) ICNIRP measured at site # A620

IV. DISCUSSION

International and national bodies have set different limit values for permissible electromagnetic radiation levels in various standards and regulations.

The European Union has recognized the importance of EMC, and all products sold in Europe must now meet the essential requirements of the EMC Directive. Compliance with these guidelines may not necessarily preclude interference with, or effects on emerging home telemedicine systems.

The background level of EMF from electrical sources has risen exponentially, most recently by soaring popularity of wireless technologies such as cell phones, cordless phones, Wi-Fi and Wi-MAX networks. Everybody is exposed to RF radiation from wireless devices such as cell phones and cordless phones, cellular antennas and towers, and broadcast transmission towers.

One prominent concern has involved possible interference with medical devices [10]. The International Electrotecnical Commission (IEC) Standard IEC 60601-1-2, sets a minimum inmunity level of 3 (V/m) for non-life supporting devices.

According with the research results reported in this communication, the base line EM levels are below the security threshold stated by ICNIRP-98. It means E field level in urban home environments are apparently safe according with the health and safety requirements regarding the exposure of patients to the risks arising from electromagnetic fields. Nevertheless, data compared with ICNIRP standard for human exposure, show high level in Wi-Fi, DECT and GSMtx bands. That can be see in Figure 9, Figure 10 and Figure 11.

The detected presence of quite high-level peaks in some frequnecy bands reveals the need to pay attention to potential EMI problems in particular cases, where can exits the possibility of RFI problems to medical devices making necessary to assess local EM conditions regarding home telemedicine risk analysis.

Proper design and installation of medical devices, coupled with proper characterization and management of potential sources of electromagnetic emission in the local environment, can guard against EMI. The potential for interference will vary from one location to the next, depending on combination, type and even the electronic equipment in use and it can be controlled through the application of appropiate EMC management practices.

V. CONCLUSSION

The development towards faster data buses and processors in electronic equipment have lead to a significant contribution of radiated emission at frequencies above 1 GHz. Wireless technology is changing rapidly in both exposure characteristics (e.g., frequencies and modulation) and usage pattern (e.g., phone use vs. text messaging or web surfing).

Real time, reliable, safe, interoperable, fully integrated wireless medical systems are expected to be deployed widely for home and personal care. The reliability of these technologies has improved, but it is far from evident which applications should use exclusive or non-exclusive frequency bands and which telemedicine applications should be excluded due to their unreliability [7].

Any new solutions must consider issues with respect to electromagnetic compatibility and regulatory compliance [8]. It would make necessary a local assessment and risk analysis prior to the installation of a home telemedicine application, about safety in EM fields for human environment and electromagnetic compatibility and inmunity of electromedical devices.

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