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Effects of 5G Radiation on the Human Body

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Abstract: Fifth generation mobile communication (5G) studies are starting to gain real momentum as we point toward the year 2020. The first 5G networks will be supporting traffic volumes more than 1,000 times higher than today with data rates up to multi-Gbps for specific scenarios. The preliminary frequency bands identified are between 6-100 GHz. This paper intends to study the effects of these frequencies on the human body since most of the 5G devices will be worn on the body. So the biocompatibility of these devices is an important issue. This paper focuses on the recent results and advances related to different aspects of interactions of 6-100 GHz frequency with the human body.

Keywords: UMTS, CPICH, EMF,

I. INTRODUCTION

In just a decade, the amount of IP data handled by wireless networks will have increased by well over a factor of 100: from under 3 Exabytes in 2010 to over 190 Exabytes by 2018, on pace to exceed 500 Exabytes by 2020. This deluge of data has been driven mainly by video thus far, but new unforeseen applications can reasonably be expected to materialize by 2020. In addition to the sheer volume of data, the number of devices and the data rates will continue to grow exponentially. The number of devices could reach the tens or even hundreds of billions by the time 5G comes to fruition, due to many new applications beyond personal communications.

The four consecutive generations of mobile communication systems have been designed for increasing the spectral efficiency as well as peak data rate. In the fifth generation, it is foreseen that other criteria such as latency, energy efficiency or EM radiation exposure will also have an important role in the design of such communication systems. The next generation will also bring some new concepts to mobile communications such as heterogeneous layout or coordinated multipoint (CoMP) communication, which will have an impact (good or bad) on the EM radiation exposure. With the growing usage of mobile communication devices by the public over longer period of times, the concerns about adverse health effects of EM radiation exposure, from mobile communication systems in particular are rapidly increasing, which brings about the need to investigate techniques for reducing EM radiation from such systems. Moreover, very few research works have explicitly focused on reducing the EM emission levels of wireless communication systems. It has been shown that using lower frequency bands in universal mobile telecommunication systems (UMTS)can reduce the EM radiation density of a BS by about 13 dB and the transmit power of the primary common pilot channel (CPICH) by about 16 dB. As there is a direct relationship between transmit power, SAR and EM radiation exposure, some wireless communication techniques that have proven to reduce the SAR and/or transmit power of mobile communication systems, and hence, EM radiation exposure levels.

II. INTERACTION OF 60 GHZ FREQUENCY WITH THE HUMAN BODY

The primary biological targets of 60-GHz radiations are the skin and eyes. Exposure of the eyes leads to the absorption of the EM energy by the cornea characterized by a free water content of 75% and a thickness of 0.5 mm. Ocular lesions have been found after high-intensity exposure of an eye (3 W/cm2, 6 min) [1]. However, studies performed at 60 GHz (10 mW/cm^2, 8 h) demonstrated no detectable physiological modifications [2], indicating that EM waves act on the cornea in a dose-dependent manner. Hereafter, we will essentially consider the interactions with the skin as it covers 95% of the human body surface. From the EM viewpoint, the skin can be considered as an anisotropic multilayer dispersive structure made of three different layers, namely, epidermis, dermis, and subcutaneous fat layer (Fig. 1). The skin also contains capillaries and nerve endings. It is mainly composed of 65.3% of free water, 24.6% of proteins, and 9.4% of lipids [3].

The permittivity data and temperature levels available at 60 GHz are summarized in table 1 from room and body temperatures.

Reference	**ε**	T(Celsius)	Method	Sample type
Gabriel[4]	7.98 – j 10.9	37	E	In vivo
Gandhi[5]	8.89 – j 13.15	37	E	In vitro
Hwang[7]	8.05 – j 4.13	24 - 26	M	In vivo

Alabaster[6]	9.9 – j 9	23	M	In vitro
Alabaster[6]	13.2 – j10.3	37	E	In vitro
Alekseev[8]	8.12 – j11.14	20-22	M	In vivo
Mixture eq.[9]	9.38 – j 12.49	30	T	-

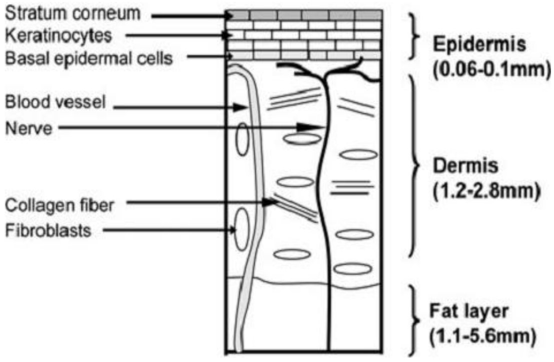

Fig [1] Human skin structure [14]

III. CONCLUSION

The paper summarizes the results of various researchers on the effect of frequency range of 60-100 GHz. The investigation of the human skin has been carried out using material parameters from the parametric model of Gabriel et al.[4] because it provides a closed form over the entire frequency range and allows to study the transition of the SAR distribution up to 100 GHz. Of course, the choice of dielectric properties influences the computational results. This effect can be estimated by the transmission coefficient of the boundary air skin. Due to the strong absorption of the electromagnetic fields in superficial tissue, the averaged values for higher frequencies are determined mainly by the parameters of the first layer of the model including the reflection coefficient of the boundary air skin. We should find a way to deal with the safety issue of EMF exposure at a reasonable cost with good reliability.

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