Human exposure to electromagnetic fields emitted by wireless communication devices: from 1G to 5G

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The International Commission on Non-Ionizing Radiation Protection (ICNIRP), a body recognized by the World Health Organization (WHO), established the guidelines for limiting human exposure to electromagnetic fields in 1998. Based on the review of the scientific literature available at that time, the guidelines provide protection against known adverse health effects of electromagnetic fields. They were updated by ICNIRP in 2020 to account for the latest research in this field. The European recommendation 1999/519/EC refers to these guidelines to define the exposure limits for the general public. For example, the peak spatial-averaged 10g specific absorption rate (SAR) of a mobile phone developed for the European market should not exceed the basic restriction of 2 W/kg. To verify the compliance boundaries of base station antennas, reference levels derived from the basic restrictions are preferably used. A similar document (IEEE C95.1-2019) has also been developed by the IEEE International Committee on Electromagnetic Safety (ICES).

To address the problem of possible health effects due to the exposure to electromagnetic fields, extensive research has been undertaken in the fields of biology, dosimetry and epidemiology during the past decades. The biological effects of electromagnetic fields are well-known and scientifically recognized but the adverse health effects on human beings are often debated. Following the review of epidemiological studies that showed a possible correlation between the extensive use of mobile phones and an increased risk for glioma, the International Agency for Research on Cancer (IARC), a specialized agency for the World Health Organization (WHO), classified human exposure to radio frequency electromagnetic fields as possibility carcinogenic to humans (Group 2B) in 2011. Studies are on-going to assess the possible relation between the use of wireless communication devices and any adverse health effects.

As novel wireless communication systems are developed and deployed –from 1G to 5G with complex modulation schemes often involving multiple antennas and higher frequencies–, added to the continuously varying intended-use positions of the devices, –e.g. from a phone used at the ear position to a connected watch worn at the wrist–, the SAR measurement to assess compliance may prove challenging. Such measurement procedures are discussed within international standardization committees such as the IEC TC 106.

The aim of the talk is to provide a review of the current state of the art on human exposure to electromagnetic fields emitted by ubiquitous wireless communication devices and networks. The rationale of the guidelines for limiting human exposure to electromagnetic fields, the limits adopted by different countries around the world as well as international standardization activities –experimental and computational– to assess compliance of wireless communication devices will be discussed.

Vikass Monebhurrun received the PhD degree in electronics in 1994 and the Habilitation à Diriger des Recherches (HDR) in physics in 2010 from Université Pierre et Marie Curie and Université Paris-Sud, respectively. He was engaged in research on electromagnetic non-destructive testing for nuclear power and aeronautical applications until 1998, following which he joined Supélec (now CentraleSupélec/Université Paris-Saclay). His research interests encompass time domain numerical modeling as well as radio frequency measurements. He actively participated in French National Research Programs on dosimetry of wireless communication systems since 1998: 2G (1999-2002) 3G (2003-2005) and 4G (2007-2010). His research contributed to international standardization committees of the European Committee for Electrotechnical Standardization (CENELEC), International Electrotechnical Commission (IEC), and IEEE. He is author and co-author of more than hundred peer-reviewed international conference and journal papers, and he holds three international patents on antennas for mobile communications. He is an active contributor within the several international standardization committees of IEC and IEEE. He was a member of the European COST Action BM 1309 on beneficial effects and medical applications of electromagnetic fields (2014-2018). Prof. Monebhurrun served as member of the Editorial Board of the IEEE COMPUMAG and IEEE CEFC conferences, and IEEE Transactions on Magnetics special issues from 1998 to 2020. He is the founder of the IEEE RADIO international conference for which he served as General Chair for all the eight editions since 2012. He serves as President of the Radio Society (Mauritius) since 2013. He currently chairs the IEC/IEEE 62704-3 and IEEE Antennas and Propagation Standards committees. He further serves as member within several committees of the IEEE Antennas and Propagation Society.

From 2019 to 2022, he was an AdCom member of the IEEE Sensors Council. He serves as Corresponding Member of the IEEE Region 8 Standards Coordination Subcommittee and IEEE Technical Activities Board Committee on Standards (TABCoS) since 2019. He served as Associate-Editor (2016-2021) and Guest-Editor (2018/2019) for the IEEE Antennas and Propagation Transactions and Editor of the IoP Conference Series: Materials Science and Engineering (2013-2019). He is currently Editorial Board member of the IEEE Antennas and Propagation Magazine and maintains a column dedicated to standards related activities. He is member of the IEEE Standards Association Board of Governors for 2024 and 2025. He was the recipient of the Union Radio-Scientifique Internationale (URSI) Young Scientist Award in 1996, the IEEE SA International Working Group Chair Award in 2017, the IEEE Ulrich L. Rohde Humanitarian Technical Field Project Award in 2018, the IEC 1906 Award in 2018 and the IEEE SA International Award in 2019.