

HEALTH AND SAFETY

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In 2020, many governments and corporations have been heavily focused on the development and implementation of 5G technology in order to meet the ever-growing demand for connectivity. This demand is due to the exponential increase in the number of bandwidths available for allocation, the increase in information that can be transmitted per unit of time, and an overall decrease in latency. As a result, it is predicted that 5G will account for over 1.2 billion online connections by 2025, and eventually replace all other previously developed telecommunications technology.ⁱ This is primarily due to technologies such as autonomous vehicles, smart cities, 4K streaming and IMT, requiring the decrease in latency and higher-information transmission that 5G promises.ⁱⁱ However, before 5G can even be implemented the auctioning and allocation of the 5G bandwidths must occur.

Governance of Telecommunications

The body responsible for developing the technical standards and for the allocation bandwidths and satellite orbits is the International Telecommunications Union (ITU); a specialized agency within the United Nations comprised of 193 Member States and over 900 companies, universities, and international and regional organizations.ⁱⁱⁱ Given the amount of political and corporate pressure for the implementation of 5G, the ITU has placed 5G and the allocation of its bandwidths at the top of its agenda at the World Radiocommunication Conference 2019 in Sharm el-Sheikh Egypt.^{iv} Although this may be beneficial to overall economic and technological growth, the health concerns and responsible use of 5G must become one of the top priorities of the ITU. They are important to consider especially with the introduction of mmwave technology.^v

History of Telecommunications on Health

Historically, the implementation of 1G, 2G, 3G and 4G technologies prompted health organizations to raise concerns regarding the health effects of electromagnetic fields (EMFs) but research conducted by the World Health Organization cautioned critics as it was determined that daily exposure to waves from

wireless devices cause no substantive health concerns.^{vii} As a result, the number of studies published regarding the effects of EMF on the human body has slowly decreased as the last WHO accredited journal article was published in 2011.^{viii} A decline in the number of studies and accredited studies is concerning since there needs to be more research conducted to ensure the safety of those that use 5G technology. This is mainly due to the fact that 5G is entirely different primarily due to the millimetre wave technology which derives its name from the size of its wavelengths (10mm to 1mm) and operates within a range of 24GHz to 100GHz.^{ix} Although implementation of 5G will be revolutionary, it is incredibly important for governments and corporations alike to also consider the potential health risks.



Figure 1: World Radiocommunication Conference in Sharm el-Sheikh Egypt 2019.

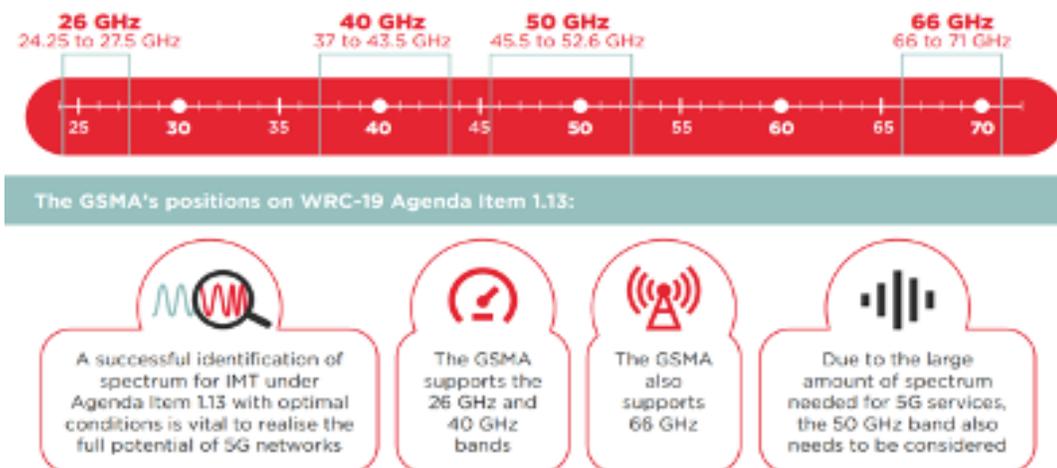


Figure 2: Frequency range in Gigahertz of 5G wave spectrum. Green boxes indicate key bandwidths. Descriptions below indicated key points on agenda for conference.

VARIABILITY IN RESEARCH

Research on the effects of new technologies is a crucial step in ensuring governments and corporations are not unintentionally placing an individual's health at risk. Collectively, over 1300 studies have been conducted by the WHO and other organizations which have (according to them) determined that EMFs do not pose significant health concerns.^{xi,xii}

According to the ITU in its Series K compliance assessment for 5G wireless networks (2019), there are approximately 350 studies specifically on the effect of mmWave radiation on human health.^{xiii} Although 350 is a fairly large number of studies, the ITU fails to distinguish if the research designs of these studies differed. First, differences variations in independent variables like frequencies, exposure times, and devices used (ie. Microwave ovens vs. 5G antennas), may lead to different results and conclusions. Furthermore, studies published on mmWave radiation have concluded that 5G do not simulate the appropriate variables - meaning these studies may not be reliable.

POTENTIAL UNIDENTIFIED HEALTH CONCERNS

Despite the potential differences in these studies, the predominant conclusion regarding the adverse health effects of mmWaves was excessive tissue heating which increases as the GHz increases and can cause harm.^{xv} Second, if it can be assumed that excessive tissue heating is the only risk associated with 5G mmWaves; individuals and workers could be at risk of necrosis of skin cells when in close proximity to a 5G antennas that are emitting mmWaves, this could lead to subsequent health risks. For this reason, nation-states and international organizations have established EMF exposure regulations for the general public and for workers based on the scientific literature available. In Germany, the Federal Emission Control Act published the recent Ordinance on Electromagnetic Fields which outlines the maximum EMF exposure for high and low EMF frequencies.^{xvi} In a period of 6 minutes an individual should not exceed an electric field strength of 61 Volts per meter (2 to 300 GHz).^{xvii}

CONSTRUCTIVE INTERFERENCE OF WAVES

Furthermore, researchers at New York University conducted a study specifically on the effects of wireless communication mmWaves on the human body and explicitly stated that limits for EMF exposure differ across countries and even organizations due to the discrepancies in data.^{xviii} Third, corporations will need to develop equipment that meets the EMF regulations of the region they are operating in (ie. Germany's, see above) but there is a risk that multinational telecommunications companies meet the regulations in one region but do not in another potentially rendering their equipment hazardous.^{xix} Furthermore, it is possible that Germany will alter their own EMF regulations once more research concerning 5G tech and mmWaves is available. Fourth, 5G mmWaves will not travel as far as 4G waves meaning the implementation of 5G tech will require more mmWave antenna stations subsequently leading to an increase in mmWave exposure.^{xx} This is another important risk factor to consider since an individual 5G antenna array may comply with EMF regulations, the sheer volume of the antennas within a given area may not comply with EMF regulations due to constructive interference.

MITIGATION:

Awareness of Regulations and Constructive Interference

Germany and the surrounding region pride itself on its engineering and production and as a result, both consumers and the government have very high standards when it comes to the quality of engineered goods.^{xxi} Aside from adverse health implications; ignoring the customs and standards for production in Germany may lead to issues in sales performance or even issues with the government. Thus, investing in R&D overall is a positive direction for companies wishing to work with 5G technology in Germany. As previously stated, regions around the world have varying EMF regulatory standards and Germany is no exception with its Ordinance on Electromagnetic Frequencies (OEF) within the Emission and Control Act. As a result, companies should be well aware of the regulations laid out by the OEF and should plan to develop equipment that does not expose the public to 61 volts/metre + of EMF radiation for greater than 6 minutes. However, given the fact that constructive interference is possible due to the proposed number of mmWave antennas required to create a 5G network;^{xxii} companies should be well aware of the risks associated with constructive interference and conduct tests to ensure that their equipment will not produce waves with a greater energy potential than regulations allow.



Ultimately, incorporating updated research and appropriate safety tests should be a critical part of all stages in the development and implantation of the 5G technology. Not only will this help support that the technology is safe but it will also show good corporate social responsibility and reassure the public, governments, and investors that the technology is safe and will be a key player in the development of IoT and new industries.

Fundamentally, there is a large discrepancy in the type, design, and quantity of both research and equipment when it comes to mmWaves. 5G technology will be the first instance where

high frequencies such as 26GHz bandwidth will be used to connect mobile devices and other wireless devices together. Based on this, there needs to be more research to protect those that work with 5G communications systems.

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