EMFields

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5G Update

There is currently a lot of concern being expressed on websites and emails about millimetre-waves (mm-waves) and 5G. It is very important to realise that these are not the same thing.

5G is a new, more technically advanced, version of the long-term-evolution (LTE) wireless communications system that effectively started with 3G. Over time it will use a variety of different carrier frequencies and modulations to transmit information. Some of these carrier frequencies will pass through buildings much more easily than others. All will be absorbed by living beings.

The rollout of 5G will be done over a number of years. Suitable 5G carrier frequencies have different properties with some carrying data further being better at passing through walls and other obstacles, while others (mm-waves) can only be used over short direct distances but can carry vast amounts of information quickly (e.g. for downloading HD movies). Because of this, and because no available mobile phone handsets currently are capable of mm-wave frequencies, the initial public network roll-out of 5G will be using carrier frequencies less than 6 GHz.

For short distance communication between mobile device (tablet or phone) and the nearest base station, higher frequencies from 24 GHz to 90 GHz (mm-waves) will be tested in locations around the world in the next few years. They will require different, more advanced, cellphone handsets and tablets. The electronic chips for these are only at an experimental stage at present.
The new cellphones will be more complicated to manufacture and the signals will be more difficult to measure accurately.

Later 5G mm-wave systems will require the deployment of millions of small low-power base stations close to people's homes and it is questionable whether that will be affordable. In most areas where fibre-optic cable has been laid it is more likely to be implemented by integrating 5G pico-cell base stations in the routers that people have in their homes. This has been done to provide widespread WiFi in several countries. BT (2017) has a network of over 5 million WiFi hotspots across the UK provided by their BT broadband subscribers – and all subscribers can use any of them to connect to the internet.

It is most unlikely that there will be a widespread rollout of any 5G networks before about 2020. The EC hopes that viable commercial existing-band (up to 6 GHz) 5G networks will be in operation by the end of 2020. The first public mm-wave networks will follow a few years later and are likely to be in high-value city business areas. We are working on instruments for detecting the mm-wave frequencies, but they are unlikely to be available for sale before 2019. There are antenna, sensor and power consumption issues that make it difficult to make cost-effective wide-band measurements at these frequencies.

In the meantime microwaves at the 5G frequencies which will be used in most areas until at least 2020 (and probably 2023) can be measured using our Acoustimeter https://www.lessemf.com/rf.html#139, AcoutiCOM2 https://www.lessemf.com/rf.html#140, and RadAware alarm https://www.lessemf.com/rf.html#137. By the time it is necessary to measure the mm-wave frequencies we will be offering new measuring instruments.

Written by Alasdair Philips, Technical Director of EMFields Solutions Ltd. 15th August 2017.
Two further pages follow with more technical information.

Further information about 5G

There are already **7**1 internationally identified potential 5G bands between 453 MHz and 6000 MHz (6 GHz) – many of these are currently used for mobile communication, nor are they available in all countries.

See: https://en.wikipedia.org/wiki/LTE_frequency_bands

Microwaves at these frequencies can be measured using our Acoustimeter, ACOM2 instruments and our new RadAware alarm.

5G is a method of modulating an RF/microwave carrier with complex QAM subcarriers. 'Microwaves' are not defined as such, but are generally considered to be wavelengths between 1 metre and 10 mm (300 MHz to 30 GHz). Millimetre-waves (mm-waves) are much higher frequencies that have a much shorter effective range and are not good at penetrating buildings but offer much greater data bandwidth. Their wavelengths are longer than infrared waves, but shorter than normal 'microwaves'. They were considered to be wavelengths in the range from 10 mm (30 GHz) to 1 mm (300 GHz), though the 24.25 GHz to 27.5 GHz band is being prioritised across Europe as the first high frequency band for 5G and is being included in the mm-wave part of the spectrum.

It is all very early days in the real world roll-out. In July 2017, Apple was awarded a licence to design, build and test experimental 5G mm-wave handsets, specifically for the FCC approved 28 and 39 GHz bands. Chipmaker Qualcomm has announced that samples of its 5G 'snapdragon' X50 28 GHz chipset will be available late in 2017 and hopefully in production quantities by the end of 2018. In July 2017, Arqiva and Samsung started a single trial of a fixed (not mobile) 28 GHz experimental one-base-station mini-network in central London.

'5G for Europe: An Action Plan' – published by the EC in 2016 states:
https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-588-EN-F1-1.PDF
"The designation of new frequency bands above 6 GHz is on the agenda of the World Radio Conference 2019 (WRC-19), based on a list of candidate bands identified at WRC-15, subject to ITU studies, with the aim of targeting the widest possible global harmonisation."

The EC hopes that: "every Member State will identify at least one major city to be "5G-enabled" by the end of 202018 and that all urban areas and major terrestrial transport paths have uninterrupted 5G coverage by 2025"

In the meantime, the UK Regulator, Ofcom, has worked with other European spectrum regulators to identify three key new bands for 5G in Europe: 700 MHz, 3.4-3.8 GHz, and 24.25-27.5 GHz. Many network operators are planning to use some of the 800/900 MHz GSM frequencies for 5G that will penetrate buildings and some existing 3G bands (e.g. 1800 MHz) will also convert to 5G. Ofcom is already planning an auction for some time in 2017, to sell off spectrum in the 2.3GHz and 3.4GHz bands. It also is reclaiming the 700–800 MHz spectrum from Digital Terrestrial Television and wireless for future 5G usage, which should be complete by the second quarter of 2020. Elsewhere in Europe, the International Telecommunication Union (ITU) has already globally allocated 200MHz of 3.4-3.6GHz spectrum and is also committed to making the ex-DTV 694-790MHz band available in Europe for 5G.

In August 2017, the FCC announced that it is looking into how 3.7-4.2 GHz; 5.925- 6.425 GHz.

However, the imagined future of 5G lies in the high frequency millimetre-wave spectrum, for which there is far more capacity. This technically encompasses the 30-300 GHz range, but it more commonly refers to bands above 24 GHz. Ofcom has identified 24.25-27.5 GHz as the so-called

"pioneer band". More commonly simplified to 26 GHz, this band is seen as the most likely candidate for a true global 5G standard.

There is not likely to be widespread deployment of mm-waves until at least 2021 and probably nearer to 2025 other than in a few high-value densely populated areas.

Some 2G (GSM) networks will continue to be supported by some companies in the fairly long-term. They still offer the most effective rural coverage at fairly low power for voice and text messages. They are also widely used for the large number of existing automated alarm and data systems that will not easily be able to be converted to LTE. However, AT&T, Telstra, Optus and the 3 Singapore operators, have already turned off their 2G (GSM) networks to clear frequencies for 4G and 5G. In most countries, 3G is much more likely to be phased out before 2G (GSM), as 3G/UTMS morphed into 4G/LTE and now the first standard for 5G/LTE (which is actually 3GPPP-12, passed in 2015) and with future technical enhancements: 3GPPP-13 (2016), 3GPPP-14 (2017) and 3GPPP-15 planned to be released in September 2018. However some networks (like Verizon, AT&T and KT) are just going ahead and creating their own 'bespoke' versions of 5G in order to try to be the market leaders.

Water is a very good absorber of millimetre waves. Wet cement will absorb almost all the mm-wave radiation impinging on its surface. Humans absorb 100% of the energy of millimetre waves which hit them.

Whether mm-waves will penetrate homes depends on many factors. Above 30GHz the waves can slip through long slots such as those around PVC window frames as the metal cores are surrounded just by PVC extrusions. This makes it difficult to shield at the scale of housing. Metal reflects millimetre waves as effectively as it reflects microwaves, but mesh is much less useful, as the smaller waves more easily slip between the wires in a mesh.

For more information on 5G and its rollout, this is an informative site:
http://spectrum.ieee.org/video/telecom/wireless/everything-you-need-to-know-about-5g
Including: Small-cell networks, Massive MIMO, Beamforming, and Full-duplex.