HM Government

5G mobile technology: a guide

5G is the latest mobile technology. It brings greater speed, capacity and functionality to mobile services, opening up new opportunities for consumers, businesses and public services.

Companies have been rolling out 5G in the UK since 2019. However, some people have raised concerns that the introduction of 5G could affect people's health and have even linked it to the coronavirus pandemic.

These claims are completely unfounded and should not be used as a basis to block or delay 5G rollout.

This guide explains the facts about 5G to help you deal with queries from the public and to combat the disinformation that is spreading online.

Ofcom

making communications work
for everyone

What is 5G?

5G is the new, fifth generation of mobile technology. Like previous mobile generations, including 3G and 4G, 5G uses the **radio spectrum**. The radio spectrum supports all of the wireless services used by people and businesses every day – including making a mobile phone call, listening to the radio or going online using Wi-Fi.

What are the differences between 5G and 3G and 4G?

There is nothing fundamentally different about the physical characteristics of the radio signals that will be produced by 5G compared to previous technologies like 3G and 4G.

Compared to previous generations of mobile services, 5G offers faster internet speeds and the ability to connect thousands of different devices in a small area. This means it could help create new 'smart' services for people in public spaces – providing real-time information to them about the local area and availability of services. It can also be used in healthcare, agriculture and other industries – for example, connecting machinery in factories to make production more efficient.

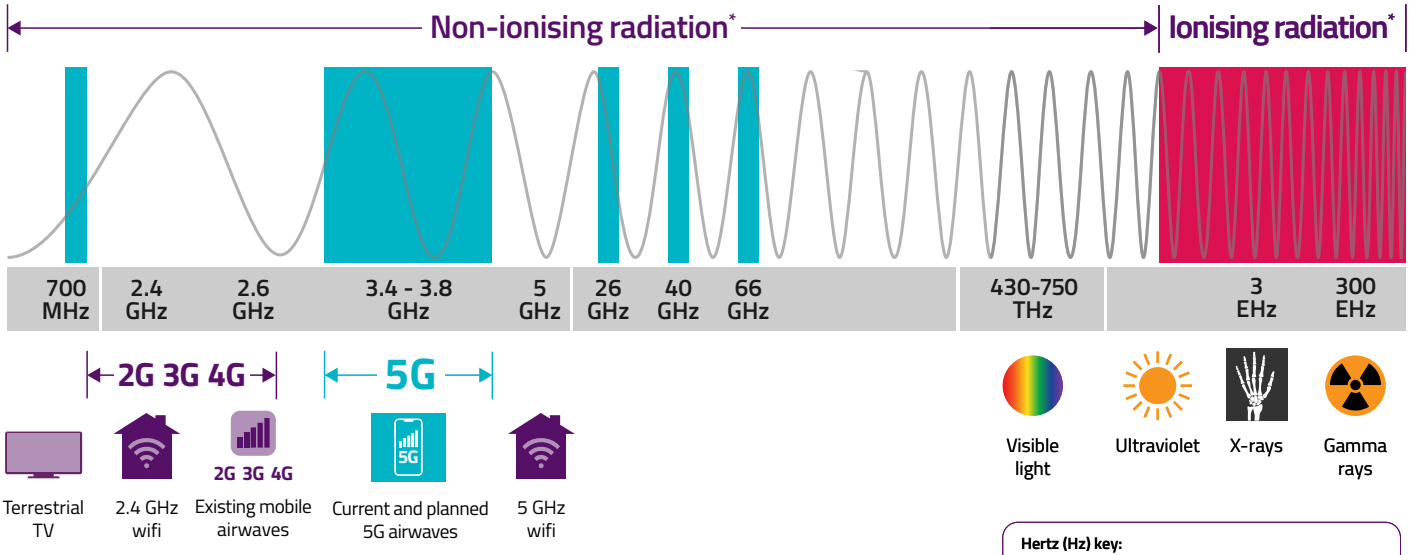
5G also makes use of certain advances in technology which are described further in this guide.

Which radiowaves does 5G use?

5G is re-using spectrum that has previously been used to deliver services such as TV broadcasting, wireless broadband and other types of transmissions that have been in the environment for many years.

Initially, mobile phone companies have deployed 5G in frequency bands which are close to those already used for previous generations of mobile technology (sometimes called low- and mid-frequency spectrum). 5G can also make use of higher frequency spectrum, and some 5G trials have already taken place in these frequencies.

All frequencies that are currently and will in future be used for 5G fall within the part of the electromagnetic spectrum that includes radiation which is classed as 'non-ionising'. This means that these radio waves do not carry enough energy to directly damage cells. This is different from 'ionising' radiation, which is generally considered to be hazardous to humans and includes gamma (nuclear) radiation as well as x-rays, which occur at the higher frequency end of the electromagnetic spectrum.



**Radio frequencies needed for common household items to work, from televisions to microwave ovens (usually between 3KHz and 300GHz), produce radiation which is classed as 'non-ionising'. This means that it does not have sufficient energy to break chemical bonds or remove electrons, as opposed to 'ionising radiation', which occurs at much higher frequencies and is generally considered to be hazardous to humans. (Source: International Commission for Non-Ionizing Radiation Protection (ICNIRP))*

Figure A: The Electromagnetic Spectrum

What do health experts say about 5G?

Health experts have studied the effects of radio waves on health for many years.

In the UK, Public Health England (PHE)[1] takes the lead on public health matters associated with electromagnetic fields, or radio waves, and has a statutory duty to provide advice to the UK Government on any health effects that may be caused by exposure to electromagnetic fields, including radio wave emissions.

PHE endorses the international guidelines for limiting exposure to radio waves, published by the International Commission for Non-Ionising Radiation Protection (ICNIRP). These guidelines cover many uses of radio frequencies, including Wi-Fi, Bluetooth and mobile technologies. The guidelines were updated in March 2020 and take full account of 5G operating at higher frequencies.

In relation to 5G, PHE have said that "the overall exposure is expected to remain low relative to guidelines and, as such, there should be no consequences for public health".

Mobile companies are also required to ensure that their signals do not exceed the limits set out in the ICNIRP guidelines for the protection of the general public.

Have 5G masts been tested to ensure they are safe?

Ofcom carries out measurements to confirm transmitter base stations do not exceed the restrictions set out in the ICNIRP guidelines. Over the past few months, **Ofcom has measured radio wave emission levels at 5G sites in 10 UK towns and cities** and, in all cases, the levels recorded are a small fraction of those in the ICNIRP guidelines.

The maximum measured at any mobile site was approximately 1.5% of the guideline levels – including signals from other mobile technologies such as 3G and 4G. The highest level from 5G signals specifically was 0.039% of the maximum set out in the guidelines.

Ofcom will continue to monitor 5G signal levels as 5G becomes more widely adopted.

Will the technological advances of 5G result in increased risks for the general public?

Use of higher frequencies (millimetre wave)

At the moment, all mobile phone companies in the UK are operating mobile services in frequencies between 700 MHz and 3.8 GHz. This includes 2G, 3G and 4G as well as all current 5G deployments. These frequencies are at the lower end of the microwave frequency range (microwaves are generally considered to encompass frequencies between 300 MHz and 300 GHz)[2].

5G can also make use of higher frequency spectrum, and some 5G trials have already taken place in these frequencies. Higher frequency bands that could be used for 5G include the 26 GHz, 40 GHz and 66 GHz frequency bands (as illustrated in Figure A above). The term millimetre wave or mmWave is often used to describe these higher frequencies. The advantage of these frequencies is that they can deliver very high speeds and high capacity with very low latency (the time between instructing a wireless device to perform an action and that action being completed).

At these frequencies, the signals do not travel as far and do not carry through walls or objects as easily as low- and mid-frequency spectrum, so they are not suited to providing wide-area mobile coverage. They are instead most likely to be used in areas with the highest demand from mobile phone users - so-called 'hotspots'.

The use of these frequencies is not new – they have been used for many years for other radio services, including point-to-point links, satellite earth stations and radio astronomy. The ICNIRP guidelines cover all frequencies that will be used for 5G, including mmWave, and all operators are required to comply with these guidelines. The latest version of these guidelines, published in March 2020, contains some additional restrictions for use at these higher frequencies.

Advanced antenna technology (massive MIMO and beamforming)

New advanced 'massive MIMO' (multiple input, multiple output) and 'beamforming' antenna technology mean that antennas used in mobile networks will be able to direct signals only to where they are needed – for example, directly to your mobile handset. This technology is already used in

1. On 18 August 2020, the Government created the National Institute for Health Protection. This brings together Public Health England, NHS Test and Trace and the analytical capability of the Joint Biosecurity Centre under a single leadership team. The organisation will be formalised and be operating from spring 2021. 2. Note, the use of the term 'microwaves' here should not be confused with 'microwave ovens' - these use a very specific set of frequencies which, incidentally, are also widely used for Wi-Fi, albeit at much lower power levels.

4G to some extent but will be used more widely in 5G.

The antennas themselves are not 'massive' in size – in fact, they are similar in size to the antennas used in previous generations of mobile technology. Rather, they are massive in that they are made up of a larger number of smaller antennas than antennas used for previous generations.

This technology means 5G transmissions will be more efficient as they will not be transmitting in directions where the signal is not needed, tending to reduce incidental radio wave exposure levels in the environment. Even so, operators will still need to ensure that the emission levels from these new antennas are compliant with the restrictions in the ICNIRP guidelines.

Small cells

At the moment, 5G equipment is generally being added to existing mobile phone masts. However, over time, more smaller transmitters (known as "small cells") may be used to provide capacity in specific locations.

While more small cells might be needed, they will operate at much lower powers than existing mobile masts as the signals do not need to travel as far. In addition, use of small cells will have the benefit of enabling mobile phones to operate at lower powers. This means that, in general, small cells will be unlikely to cause any increase to the overall radio wave exposure levels experienced by a mobile phone user, and may cause a decrease.

However, a significant increase in the number of small cells is not expected immediately as operators are concentrating on adding 5G technology to their existing sites.

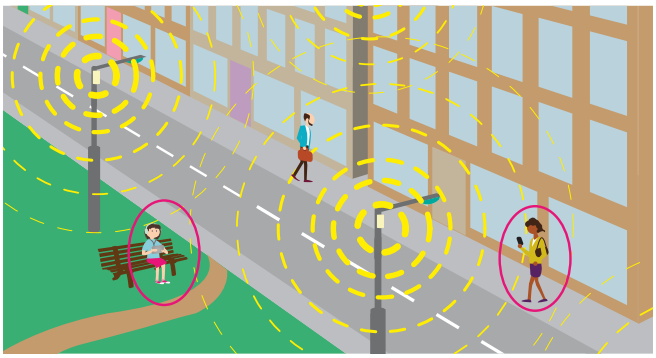


Figure B: Small cell deployment in a city centre

5G and Coronavirus

Recently, conspiracy theories have been shared online that claim 5G mobile is connected to the spread of the coronavirus. This is wrong. There is no scientific basis or credible evidence for these claims.

Some areas of the country have seen mobile phone masts vandalised because of these incorrect claims. Engineers from the mobile phone operators have also been threatened in the street while they work. These types of incidents put lives at risk. If a mobile phone mast stops working, either because it has been vandalised or because engineers can't carry out vital maintenance, people in that area can't call the emergency services, dial the NHS on 111 or contact their friends or family.

Mobile phones have been used by volunteers to organise support for their local communities to collect medicines and get food for those who cannot go out during the Covid-19 crisis. People's safety and wellbeing can be put at risk if the mobile phone network isn't available.

Which organisations are responsible for public safety relating to 5G?

The UK Government's priority is to promote investment and innovation in 5G, to ensure that services and applications are widely available for the benefit of UK consumers and businesses, to drive economic growth and boost productivity. The UK Government has published guidance in respect of 5G and coronavirus (COVID-19), and the sharing of false information.

Planning law and policy requires that planning applications for electronic communications development should be accompanied by a statement or declaration that certifies that when operational, equipment will be compliant with the ICNIRP guidelines for limiting exposure to electromagnetic fields[3].

Public Health England (PHE) takes the lead on public health matters associated with electromagnetic fields, or radio waves, and has a statutory duty to provide advice to Government on any health effects that may be caused by exposure to electromagnetic field emissions. PHE has published advice on exposure to radio waves at the following link: https://www.gov.uk/government/collections/electromagnetic-fields#radio-waves

Ofcom is responsible for managing use of the radio spectrum in the UK. Ofcom regularly carries out radio frequency electromagnetic field (EMF) measurements near mobile phone base stations to test whether EMF levels are within ICNIRP guidelines. Further information on Ofcom's work in relation to EMF is available at the following link: https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/mobile-wireless-broadband/exposure-electro-magnetic-fields.

3. Planning law is a devolved matter. Please see: The Town and Country Planning (General Permitted Development) (England) Order 2015 (as amended); The Town and Country Planning (General Permitted Development) (Scotland) Order 1992 (as amended); The Town and Country Planning (General Permitted Development) (Wales) Order 1995 (as amended); The Planning (General Permitted Development) Order (Northern Ireland) 2015.

Department for Digital, Culture, Media & Sport

Ministry of Housing, Communities & Local Government

7th March 2019

Collaborating for digital connectivity

Government is committed to supporting investment in high-quality, reliable digital connectivity so that communities can benefit from faster economic growth and greater social inclusion. It is essential to keep pace with growing demand for internet bandwidth and mobile data from local businesses, residents and those who visit our communities. As outlined in the Future Telecoms Infrastructure Review, the Government would like to see nationwide full fibre coverage by 2033. We would also like the UK to be a world leader in 5G, with the majority of the population covered by a 5G signal by 2027. We are writing to ask for your help in supporting the investment necessary to achieve these objectives.

Recent years have seen substantial investment in mobile and fixed digital infrastructure across the UK. In 2016 the Gross Value Added from the digital sector was £116.5 billion, which equates to 6.7% of the UK economy, so the benefits for individuals and the UK as a whole are substantial. While mobile coverage across the UK has been significantly improving, there are still too many areas where coverage is poor. The UK has now achieved 95% superfast broadband coverage but still only 6% full fibre coverage.

We need to create the market and policy conditions necessary to support the large-scale commercial investment required to extend and future-proof digital connectivity. A key part of this is making it easier for operators to deploy infrastructure. To help to achieve this, the Government recently reformed the Electronic Communications Code - the statutory framework which underpins agreements between communications network providers and those in both the private and public sector who can provide sites for the installation of network equipment. The purpose of the reforms was to make it easier and more cost effective for communications network providers to deploy and maintain digital infrastructure.

Local authorities have an essential role to play as site providers. As Chief Executives, you can support investment in digital communications infrastructure by ensuring your organisations have policies and procedures in place that promote effective engagement with the digital communications industry and minimise barriers to deployment.

We have published guidance for local authorities and network operators on areas such as digital leadership, considerations for the local planning authority, streetworks, and on making local authority assets available to network operators for the installation of networks. This advice follows on from the Digital Infrastructure Toolkit, which was published in 2018 and provides advice for central government and network providers regarding access to government sites.

We welcome the efforts that some local authorities have already made to enable network deployment. In future, the Government intends to publish information on how effectively local authorities are engaging with industry and adopting the principles outlined in this guidance. We would, therefore, ask you:

1. To ensure your teams are aware of, and using, the guidance the Government has provided to improve broadband and mobile connectivity in their areas.
2. If you have not already, identify a Digital Infrastructure Champion within your organisation and share these contact details with local.connectivity@culture.gov.uk, and
3. In particular, to ensure your teams are granting access to your assets and infrastructure effectively to support the rollout of full fibre and mobile networks.

I hope you agree that we should work hand in hand to support the significant new investment in digital infrastructure that can benefit our communities. With this in mind, Government will give significant weight to the extent to which local authorities have adopted the principles contained in our guidance when allocating funding for future DCMS projects aimed at boosting investment in fibre or mobile networks.

If you or any of your colleagues have any questions, please contact DCMS at localconnectivity@culture.gov.uk.

Thank you in advance for your cooperation.

Department for Digital, Culture Media & Sport

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Minister for Digital Infrastructure
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100 Parliament Street
London SW1A 2BQ

www.gov.uk/dcms
enquiries@dcms.gov.uk

Local Authority
Chief Executives - England Only

INT2021/09526/DC
24 May 2021

Dear Chief Executives

Mobile Connectivity and 5G infrastructure - Planning

Digital connectivity is – now, more than ever – vital to enable people to stay connected and businesses to grow. The demand for mobile data is increasing rapidly, and the COVID-19 pandemic has highlighted how important it is that we all have access to reliable, high quality mobile connectivity.

The Government is committed to extending mobile network coverage across the UK and providing uninterrupted mobile signal on all major roads, and our ambition is for the majority of the population to have access to a 5G signal by 2027. Last year we agreed a £1 billion Shared Rural Network deal with the UK's mobile network operators to extend 4G mobile geographical coverage to 95% of the UK by 2025.

The Government is also investing £200 million in a programme of 5G testbeds and trials to encourage investment in 5G so that communities and businesses can benefit from this new technology. The increased capacity, reliability and functionality offered by 5G is opening-up the potential for new, innovative services for individuals and increased productivity for industry.

The planning system plays a key role in delivering the infrastructure that we need as households and businesses become increasingly reliant on mobile connectivity. Following our consultation on the principle of reforms to permitted development rights to support 5G deployment and extend mobile coverage[1], we recently published a technical consultation on the details of our proposed changes.[2]

[1] Proposed reforms to permitted development rights to support the deployment of 5G and extend mobile coverage

[2] Changes to permitted development rights for electronic communications infrastructure: technical consultation

The National Planning Policy Framework ("the Framework") for England states that planning policies and decisions should support the expansion of electronic communications networks, including next generation mobile technology, such as 5G.

The Framework is clear that decisions on applications should be made as quickly as possible, and within statutory timescales unless a longer period has been agreed by the applicant in writing. In relation to electronic communications development, it also states that local planning authorities must determine applications on planning grounds only and they should not seek to prevent competition between different operators, or question the need for an electronic communications system. As set out in planning practice guidance, it is in the public interest for local planning authorities to have effective delegation arrangements in place to ensure that decisions on planning applications that raise no significant planning issues are made quickly and that resources are appropriately concentrated on the applications of greatest significance to the local area.[3]

We know that some constituents have expressed concerns about the potential harmful effects on human health of 5G. Public Health England (PHE), the Government's independent advisers on matters of public health, is clear that there is no credible evidence of a negative impact of mobile technology, including 5G on people's health. Central to PHE's advice are the guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), which is formally recognised by the World Health Organisation.[4]

The National Planning Policy Framework requires mobile infrastructure providers to self-certify their compliance with the ICNIRP guidelines. It also sets out that local planning authorities should not set health safeguards different from the International Commission guidelines for public exposure.

The Government has developed guidance to help councils and local politicians deal with queries from the public, counter misinformation and explain the facts about 5G.[5] This will help support your role in facilitating the rollout of next-generation infrastructure, and prevent misleading claims becoming a barrier to rollout. As part of the support the Government is providing to local authorities on mobile infrastructure and the Town and Country Planning Regulations, we will be arranging a webinar on this topic for local authorities, and would encourage your planning teams to attend. Please contact the email address below for further information.

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[3] Planning Practice Guidance - Determining a planning application

[4] A summary of Public Health England's advice on radio waves can be accessed at: https://www.gov.uk/government/collections/electromagnetic-fields#radio-waves; Ofcom takes frequent measurements of EMF levels near mobile base stations to ensure compliance with international guidelines. These measurements can be found on Ofcom's website at: https://www.ofcom.org.uk/spectrum/information/mobile-operational-enquiries/mobile-base-station-audits.

[5] 5G mobile technology: a guide; Mobile UK, the industry representative body, has also published a Local Authority Toolkit for councillors and officers to help explain how 5G technology works.

If you or any of your colleagues have any questions, please contact the Department for Digital, Culture, Media and Sport at localconnectivity@dcms.gov.uk.

Yours sincerely,

Matt Warman MP
Minister for Digital Infrastructure

Cc: Local Authority Chief Planning Officer

Department for Digital, Culture, Media & Sport

INT2019/11842/DC
November 2019

Local Authority Chief Executives

5G - The Next Mobile Generation

More than any previous generation of mobile networks, 5G has the potential to transform the way we live and improve economic productivity. Networks will have the capacity for millions more devices to be connected at the same time, enabling businesses and communities to operate more efficiently. It will allow cities and communities to manage traffic flow, monitor air quality and control energy usage through real-time management of high volumes of data.

A recent report estimated that local authorities will share collectively an annual £2.35 billion of efficiency savings, from reduced social care costs for the elderly through 5G monitoring, to savings through smarter street lighting.[1] We want the UK to take early advantage of these benefits, so it is good news that all of the four main mobile network operators - EE, O2, Three and Vodafone - have started to deploy 5G networks. We expect 5G to go live in up to 50 cities and towns by the end of 2020. In order to support the deployment of 5G and extend mobile coverage, particularly in rural areas, the Government recently published a consultation on the principle of proposed reforms to permitted development rights, which closes on 4 November.

The National Planning Policy Framework ("the Framework") for England[2] supports the expansion of high quality communications, including next generation mobile technology, such as 5G. The Framework states that planning applications for mobile base stations should include a statement of compliance with international guidelines on limiting exposure to electromagnetic fields known as the International Commission on Non-Ionizing Radiation Protection guidelines ("the ICNIRP guidelines"[3]). It also states: "Local planning authorities must determine applications on planning grounds only. They should not seek to prevent competition between different operators, question the need for an electronic communications system, or set health safeguards different from the International Commission guidelines for public exposure."

Public Health England ("PHE") has recently updated its advice in respect of 5G and states: "It is possible that there may be a small increase in overall exposure to radio waves when 5G is added to an existing network or in a new area. However, the overall exposure is expected to remain low relative to guidelines and, as such, there should be no consequences for public health."[4] I understand that PHE colleagues regularly provide

[1] "The value of 5G for cities and communities", Juniper Research and O2 https://d10wc7q7re41fz.cloudfront.net/wp-content/uploads/2018/03/Smart-Cities-Report.pdf

[2] https://www.gov.uk/government/publications/national-planning-policy-framework--2

[3] https://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf

[4] https://www.gov.uk/government/publications/5g-technologies-radio-waves-and-health

advice to your public health officers across a range of health topics.

In compliance with PHE advice, mobile network operators have committed to follow the ICNIRP guidelines. ICNIRP is an independent organisation which is formally recognised by the World Health Organisation. It issues guidelines on human exposure to electro-magnetic fields, based upon the consensus view of a large amount of research carried out over many years. This includes the frequencies used by 5G and all other mobile / wireless technologies. Over the last two decades there have been over 100 expert reports on EMF and health published internationally[5] with well over 3,000 studies[6] informing these reviews and the existing scientific exposure guidelines.

Ofcom will carry out audits of mobile base stations on an ongoing basis to ensure that ICNIRP guidelines are not exceeded and publish the results of these audits on its website.

The Department for Digital, Culture, Media and Sport (DCMS) is working with colleagues in Ofcom, PHE and the network operators to provide some workshops for the benefit of council officials to help them understand the technology and the science relating to these health concerns. DCMS officials are also working with both the Local Government Association and the Association of Directors of Environment, Economy, Planning and Transport to support local authorities in this regard and would welcome any further feedback through those channels or directly.

If you or any of your colleagues have any questions, please contact DCMS at enquiries@culture.gov.uk.

Matt Warman MP
Parliamentary Under Secretary of State for
Digital and Broadband

[5] https://www.gsma.com/publicpolicy/consumer-affairs/emf-and-health/expert-reports
[6] https://www.emf-portal.org/en

Local Authority Toolkit

5G & Health

Mobile UK

Introduction

Many people are unaware of the benefits of 5G or misunderstand what it is.

This is often because the information publicly available about 5G uses technical jargon, which makes it difficult to understand and explain to others. As a result, people can sometimes be swayed by false theories and unsubstantiated claims that 5G presents a danger to our health. This document has been created to help overcome some of the barriers to understanding this exciting technology. Over the following pages, we cover:

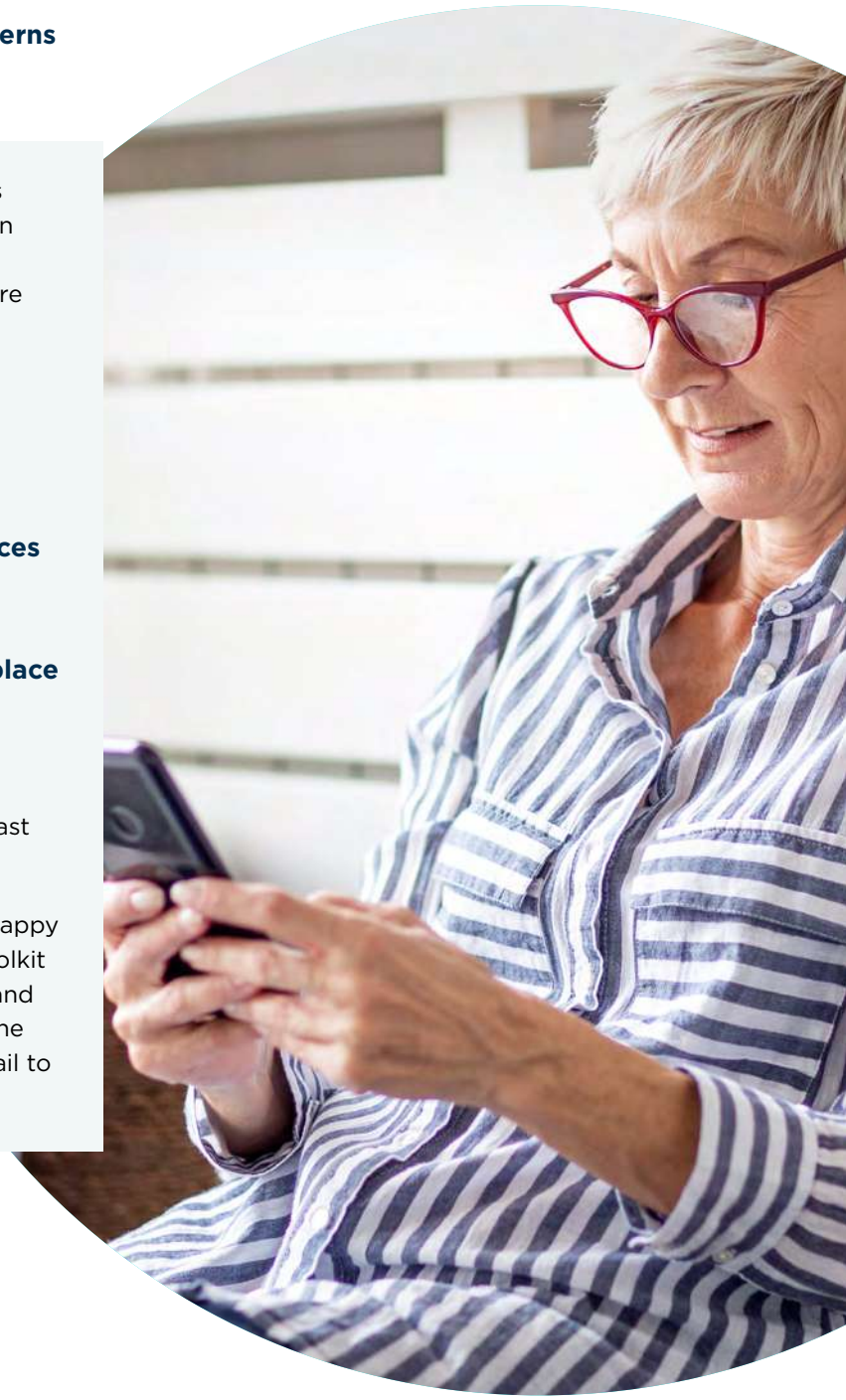
- **What is 5G?**
- **What difference will 5G make to our lives?**
- **Myth-busting facts to address common concerns**

Also available to accompany this toolkit is a series of information packs outlining the benefits of 5G in specific settings and sectors, brought to life with case studies and relevant statistics. These packs are available on the Mobile UK website and cover the following topics:

- **How 5G will help healthcare**
- **How 5G will increase rural opportunities**
- **How 5G will support the emergency services**
- **How 5G will help councils**
- **How 5G will improve the home and workplace**
- **How 5G will help the environment**

On the website you will also find an additional information document which may be useful for mast planning applications, as and when necessary.

If you would find it useful we are also more than happy for you to publish any of the documents in this toolkit on your own channels and share with colleagues and constituents. If you wish to do so and would like the documents to be co-branded please send an e-mail to info@mobileuk.org.



What is 5G?

In a nutshell, 5G is the fifth generation of mobile internet connectivity, succeeding 4G, 3G and before that 2G.

It will offer much faster data download and upload speeds and will allow more devices to simultaneously access the mobile internet.

As the world depends more and more on mobile connectivity and we are consuming more data, existing networks are becoming congested. This is particularly the case when there are lots of people in the same place, at the same time, trying to access online services.

5G has the capacity to handle this demand and has the unique ability to 'splice' the network. This gives councils, businesses and the emergency services the ability to have their own dedicated, reliable part of the 5G network.

Due to its speed, ability to connect multiple devices at the same time and the significant drop in the time it will take to send information from one point to another, 5G has the power to transform and save lives.

What difference will 5G make?

Now, we know that on paper 5G sounds like an improvement, but what difference will it really make. How will it improve our lives on a day-to-day basis?

High speed mobile internet

Everyone will have access to fast and uninterrupted sharing, streaming, and browsing via their mobile phone network. It will mean accessible near gigabit capable speeds when you are out and about and could, in the future, work alongside or provide an alternative to fibre and wires in the home.

Multiple connected devices

Countless devices will be able to access mobile online services at the same time. It will mean you can always stay connected. For example, if you are at a football stadium or a crowded festival with everyone trying to simultaneously upload and share their experiences to social media without loss of connection.

Reducing latency to a minimum

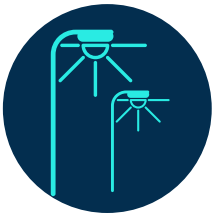
Delays between information sent and received will become virtually impossible to perceive. Real-time content sharing and data will become a reality. This will effectively make buffering and loading delays a thing of the past, with data only taking 1 millisecond to be received by a device after it has been requested – it currently it takes up to 60 milliseconds.

How will 5G make a difference to the environment?

5G will help make towns and cities more sustainable, reducing energy consumption

5G will not just improve our day-to-day connectivity, it will help reduce the environmental impact of our towns and cities, and ultimately, help save lives.

5G will be crucial in further enhancing smart cities, connecting multiple devices and sensors that will make our societies more sustainable and increase resource efficiency. For example:



5G-connected streetlights will detect when streets are empty and dim lighting to save energy, emit less CO_2 and reduce local council carbon tax contributions

5G connections between appliances and services providers and your home can reduce your household energy use and costs

Smart transport systems will help us reduce emissions when we travel

Home solar power and small-scale wind farms will integrate instantly with the national grid to share excess renewable energy

We will be able to download data in a more efficient way, using less energy

CASE STUDY

In partnership with Telefonica, the Spanish city of Malaga has converted its street lights to be 5G-connected. This allows for lighting to be adjusted according to conditions and for faulty street lights to be immediately identified. Malaga has cut its energy bill to the tune of millions as a result.

Source: O2

Mobile UK

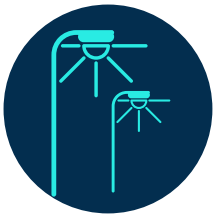
How will 5G make a difference to towns and cities?

5G will not just improve our day-to-day connectivity, it will help make our towns and cities safer, and ultimately, help save lives.

5G will help make the roads in our towns and cities safer and minimise congestion

Connected cars will communicate with each other, vastly reducing the number of accidents and resulting traffic jams and allowing cars to travel close together to keep traffic moving steadily

Connected devices will be able to alert drivers of upcoming hazards, detecting accidents before they happen and protecting vulnerable road users



Smart streetlights can include sensors to detect noise and disturbances that may relate to citizen safety concerns

CASE STUDY

Glasgow is trialling a smart street system lighting which also detects noise and disturbances that may relate to citizen safety concerns.

Source: Future City Glasgow Website

Mobile UK

How will 5G make a difference to the emergency services?

5G will not just improve our day-to-day connectivity, it will ultimately help save lives.

5G will help save lives by revolutionising the way emergency services operate

5G will further enhance the capabilities of existing 4G-enabled connected ambulances which means doctors and surgeons, in hospital, can virtually assist paramedics at the scene of an incident, saving vital minutes treating the patients

With 5G-enhanced video links at the scene of an emergency, the control room will be able to see what is happening in real time and with more clarity than 4G - including the precise positions of all emergency personnel

4G and 5G enabled drones will be able to act like police helicopters, observing large areas, providing live footage to help keep crowds safe and monitoring emergency situations such as a large fire or major incident, at a fraction of the current cost

Smart traffic light systems will allow an ambulance to change traffic lights to clear congestion along their route, improving vital response and arrival times in an emergency

CASE STUDY

In Bristol, thermal cameras specifically designed to alert the authorities when people fall into the water, were installed in the harbour. The technology was put in place after ten people tragically died drowning in one year alone. The council control centre is notified via 5G when a person breaks the virtual barrier at the harbour edge and fire and rescue are subsequently alerted. The lives of two people have already been saved using the technology.

Source: BristolLive

Mobile UK

How will 5G make a difference to public health?

5G will help tackle public health crises

5G will not just improve our day-to-day connectivity, it will improve our health, tackle loneliness and isolation and ultimately, help save lives.

5G-connected drones will be able to deliver essential medicines to patients in remote areas, or those with accessibility issues

5G-connected wearables, such as fitness wristbands and body monitors, can provide critical health updates to GPs and other medical professionals, alerting them to potentially life-threatening issues, such as falls, premature heart attacks and strokes

5G-connected health devices could help doctors and GPs remotely diagnose and support treatment plans, meaning patients will have quicker access to healthcare and doctors will be able to see more patients

5G will allow council's to improve health and social care provision, while saving money. 5G-connected devices will help care for people in their homes and within care settings, such as using telehealth to monitor vital signs remotely, reduce loneliness and observe medicine administration using 4K video. The 5G networks will enable councils to be at the forefront of the latest technology to support their citizens

CASE STUDY

5G trials in Liverpool have focussed on the use of the technology in social care settings. Sensors detect accidents and concerning behaviour patterns of vulnerable people while in their own home. A push-of-the-button device was created so that isolated residents could instantly talk to somebody when they are feeling lonely. These innovations - that help residents live in their own home for longer - can only be reliably rolled-out with 5G.

Source: Liverpool 5G

Your questions answered

5G & cancer

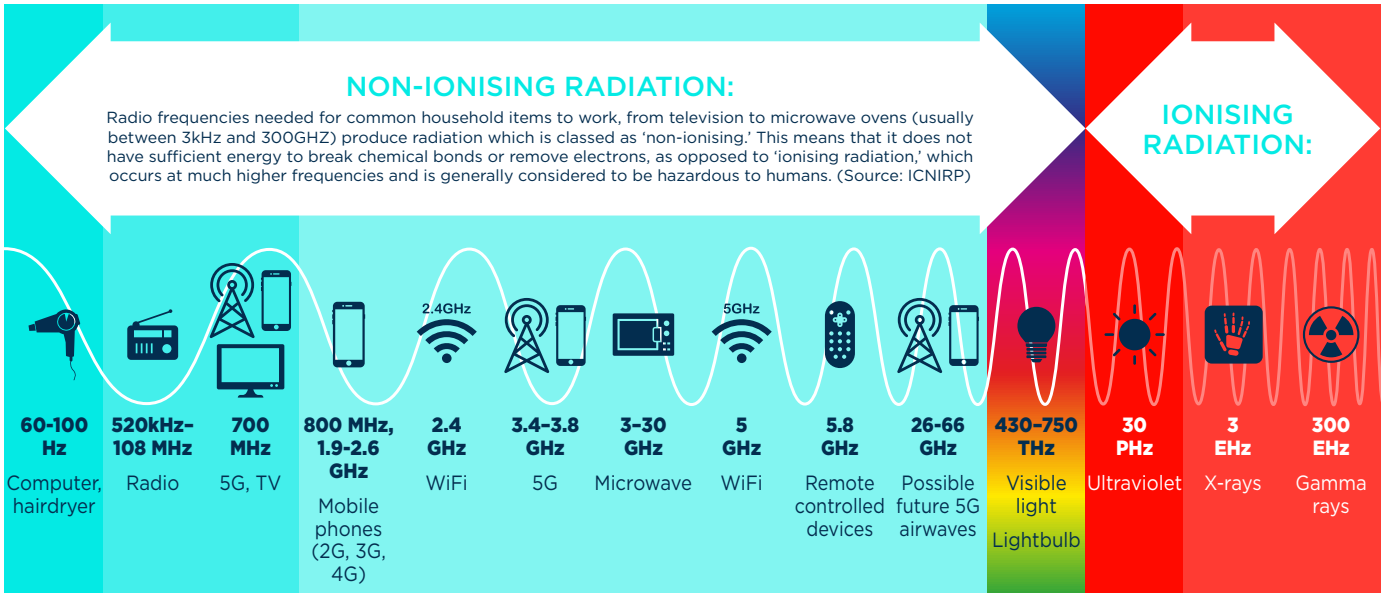
We are aware that some people are concerned that 5G could cause cancer. Importantly, this type of radiation is classed as mainly harmless when used within guidelines.

There is currently no scientific evidence to show that using mobile phones, or 5G within guidelines increases the risk of cancer.

Mobile phones and mobile masts transmit and receive radio waves, which are a type of electromagnetic radiation. Importantly, this type of radiation is classed as mainly harmless, or in scientific terms, non-ionising, just like our TVs, remote controls, home WiFi and so on. The strength of the signals is extremely weak and therefore does not have enough energy to damage DNA or directly cause cancer.

Many people who are concerned about 5G and cancer cite that the International Agency for Research on Cancer classified mobile phones as 'possibly carcinogenic.' This dates back to 2011, following a series of studies that were not considered conclusive, nor did they take into account factors that could distort the data. Mobile signals were therefore added to this category as a precautionary measure. To put this in context, talcum powder and eating pickled vegetables are also classed as 'possibly carcinogenic.'

It is widely recognised that non-ionising radiation is not capable of directly causing cancer when used within guidelines. As you can see from the graph below, 5G still falls way short of the ionising (harmful) part of the spectrum.



Mobile UK

Your questions answered

Masts and radiation

What type of radiation does 5G use?

Sometimes the word 'radiation' scares people, because it is an invisible thing and something many people do not understand, or easily confuse with 'radioactivity.'

Radiation is simply the release of energy, just like the light from the sun, or heat from our bodies. Most radiation is harmless, or in scientific terms non-ionising. It is part of our everyday lives, without us even realising it. Many household items such as our TVs, radios, lightbulbs, remote-controlled toys and WiFi, even our own bodies, emit a level of radiation. But importantly, the levels we are exposed are so low they are not powerful enough to cause adverse health effects. 5G, mobile phones and masts all safely fall into the same category.

Are 5G masts dangerous?

The strong consensus of scientific opinion and public health agencies, such as the World Health Organisation, is that no health risks have been established from exposure to the low-level radio signals used for mobile communications, including 5G.

While masts (or base stations) transmit and receive radio waves to connect the users of mobile phones and other devices to the internet, the strength of those radio waves is very low, in publicly accessible areas.

The UK's telecoms regulator, OFCOM carried out tests at 5G-enabled mobile masts across the country. The highest emission levels (e.g. radiation) recorded at mobile phone masts were consistently well within the strict safety guidelines that monitor radiation levels.

These strict guidelines are governed by the International Commission on Non-Ionising Radiation Protection (ICNIRP) a universally acknowledged non-governmental organisation recognised by the World Health Organisation (WHO). The guidelines apply to frequencies up to 300GHz, well within the frequencies that could be used for 5G. Anything below this threshold is considered to not cause adverse health effects and is therefore safe for the public.

What type of radiation is 5G?

5G uses a specific frequency of radio waves to deliver the internet to mobile devices, just like 4G and 3G before that.

This type of radiation, and for that matter much stronger radiation, is commonly part of our daily lives as explained above. In the UK, existing 4G signals sit between 800MHz and 2.6GHz. Whereas 5G will operate at 700MHz and 3.4GHz to 3.6GHz – the TV remote you use several times a day operates at 5.8GHz.

Visible light is also a type of radiation, for example the light from your TV or a lightbulb. This is much higher than these everyday items but is still classed as non-ionising, and therefore not associated with any adverse health effects. Visible light operates at a frequency 100,000 times higher than 5G.

Dangerous radiation, that can cause harm from prolonged exposure, like UV rays from the sun, X-rays and gamma rays are even higher up the spectrum – at frequencies a quadrillion times higher than 5G.

Ofcom, the telecoms regulator, states:

"All frequencies that are currently and will in future be used for 5G fall within the part of the electromagnetic spectrum that includes radiation which is classed as 'non-ionising'. This means that these radio waves do not carry enough energy to directly damage cells. This is different from 'ionising' radiation, which is generally considered to be hazardous to humans and includes gamma (nuclear) radiation as well as x-rays, which occur at the higher frequency end of the electromagnetic spectrum."

Further Information

For further information, below we have listed additional external sources that you may find helpful in regard to 5G and health.

Ofcom and HM Government 5G health guide:
https://uploads-ssl.webflow.com/5b7ab54b285deca6a63ee27b/5f3fbf86c97b38101210ae5a_5G%20EMF%20Guide.pdf

Public Health England - 5G technologies: radio waves and health:
https://www.gov.uk/government/publications/5g-technologies-radio-waves-and-health/5g-technologies-radio-waves-and-health

World Health Organization (WHO) - Radiation: 5G mobile networks and health:
https://www.who.int/news-room/q-a-detail/radiation-5g-mobile-networks-and-health

Which? - Is 5G safe?:
https://www.which.co.uk/news/2020/06/is-5g-safe-everything-you-need-to-know-on-the-5g-powered-future/

BBC - Does 5G post health risks?:
https://www.bbc.co.uk/news/world-europe-48616174

BBC Click - Testing the safety of 5G:
https://www.youtube.com/watch?v=k2t1dUCyE0I&feature=youtu.be

Cancer Research UK - Do mobile phones cause cancer?:
https://www.cancerresearchuk.org/about-cancer/causes-of-cancer/cancer-myths/do-mobile-phones-cause-cancer

#5G CHECK THE FACTS

mobileuk.org

Mobile UK

5G Masts & Health

5G is a generation leap in mobile technology with multiple benefits. However, with new technology, it is understandable that people wish to seek reassurance as to its safety and how it works.

This guide provides an explanation of 5G and the equipment behind it, including the antennae and the masts, to ensure that there is no cause for concern in regard to health.

5G & Radio Waves

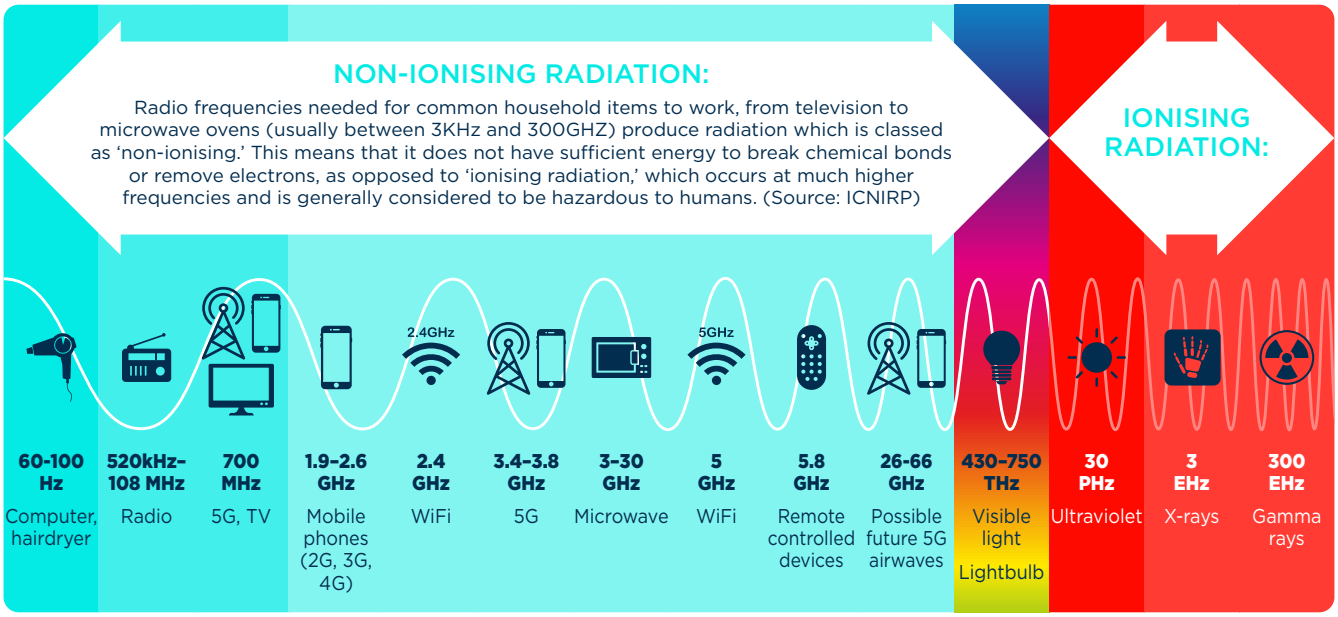
5G is broadcast using radio waves, which are a type of radiation in what is commonly referred to as the 'electromagnetic spectrum.' Sometimes the word 'radiation' scares people, because it is an invisible thing and something many people do not understand, or easily confuse with 'radioactivity.'

Radiation is simply the release of energy, just like the light from the sun or heat from our bodies. Most radiation is considered harmless, or in scientific terms, non-ionising when used within guidelines. It is part of our everyday lives, without us even realising it. Radio waves are used by your TV, radio and remote control.

5G uses a specific frequency of radio waves, just like 4G and before that 3G. The exposure to these radio waves is very low and crucially, many times lower than public safety guidelines dictate.

All frequencies that are currently and will in future be used for 5G fall within the part of the electromagnetic spectrum that includes radiation which is classed as non-ionising. This means that these radio waves do not carry enough energy to directly damage cells. This is different from 'ionising' radiation, which is generally considered to be hazardous to humans and includes gamma (nuclear) radiation as well as x-rays, which occur at the higher frequency end of the electromagnetic spectrum.

- Ofcom



5G Masts & Health

Research into the safety of 5G and mobile phone signals

Research into the safety of radio waves has been conducted for more than 80 years, across the UK and around the world. The strong consensus of scientific opinion and public health agencies, such as the World Health Organisation (WHO), is that no dangers to health have been established from exposure to the low-level radio signals used for mobile communications, including 5G, when used within guidelines.

Strict safety guidelines

All mobile operators must ensure that their radio base stations (also known as masts) are designed and built so that the public are not exposed to radiofrequency fields above the strict safety guidelines which govern and limit public exposure to electromagnetic fields. In fact, base stations operate at low levels, emitting levels of radio waves many times lower than the guidelines.

The International Commission on Non-Ionising Radiation Protection (ICNIRP) is the universally recognised non-governmental organisation that governs the safety levels of electromagnetic field or radio wave exposure and is accepted by the World Health Organisation (WHO). The guidelines, updated in 2020, monitor frequencies up to 300GHz, anything below this threshold is considered to not cause adverse health effects and is therefore safe for the public. 5G radio waves fall well within this category, operating at 700MHz and between 3.4GHz 3.6GHz.

Testing of 5G masts

In fact, the UK's telecoms regulator Ofcom carried out tests at 5G-enabled mobile masts across the country. The highest emission levels (e.g. radiation) recorded at mobile phone masts were consistently well within the strict safety guidelines that monitor radiation levels.

Further Information

As the world depends more and more on mobile connectivity and we are consuming more data, existing networks are becoming congested. 5G has the capacity to handle this and future demand, as it will offer much faster data and upload speeds, allow more devices to access the mobile internet at the same time, and significantly reduce the amount of time it takes to send information from one point to another.

The rollout of 5G is not just about the benefits to each individual mobile phone user but the wider societal benefits of providing connectivity to all, such as the emergency services, local businesses and the provision of council services; the capability of 5G can transform, and ultimately help save lives.

For more information on 5G and health, and to learn about the wider benefits of 5G visit **www.mobileuk.org.uk/5G-and-health**

For further information from external sources regarding 5G and health, the following links may be helpful:

World Health Organization (WHO) - Radiation: 5G mobile networks and health: **https://www.who.int/news-room/q-a-detail/radiation-5g-mobile-networks-and-health**

BBC - Does 5G post health risks?: **https://www.bbc.co.uk/news/world-europe-48616174**

Which? - Is 5G safe?: **https://www.which.co.uk/news/2020/06/is-5g-safe-everything-you-need-to-know-on-the-5g-powered-future/**

BBC Click - Testing the Safety of 5G: **https://www.youtube.com/watch?v=k2t1dUCyE0I&feature=youtu.be**

Cancer Research UK - Do mobile phones cause cancer?: **https://www.cancerresearchuk.org/about-cancer/causes-of-cancer/cancer-myths/do-mobile-phones-cause-cancer**

The Institution of Engineering and Technology

Allaying health concerns regarding 5G and exposure to radio waves

An IET guide for policy makers and local planning authorities
2nd edition

theiet.org/5G-health

Contents

Allaying health concerns regarding 5G and exposure to radio waves is published by the Institution of Engineering and Technology.

Please note that the views expressed in this publication are not necessarily those of the IET. It is not intended to be a guidance note with a specified set of recommendations or actions but rather seeks to add understanding and debate around the topic.

The Institution of Engineering and Technology

The Institution of Engineering and Technology (IET) is working to engineer a better world. We inspire, inform and influence the global engineering community, supporting technology innovation to meet the needs of society. The Institution of Engineering and Technology is registered as a Charity in England and Wales (no. 211014) and Scotland (no. SC038698).

About this guide

This Institution of Engineering and Technology Guide aims to give policy makers and Local Planning Authorities a better understanding of what 5G is, and what it is not, as it affects the concerns that have been expressed about exposure to radio waves.

The document is intended as a brief overview and references for further reading are provided in the footnotes.

Prof Will Stewart FREng, FInstP, FIET, FOSA
Chairman of the IET Digital Communications Policy Panel

Prof Stephen Temple CBE FREng CEng FIET
IET Guide Lead Editor

The IET Digital Panel would welcome any comments you may have on the contents/ your ideas for future digital publications. Please get in touch via **sep@theiet.org**.

Foreword

There has been an "infodemic" of misleading and false information circulating in the media about 5G and alleged health effects. Some of it is pure fantasy, but there have also been sincere concerns expressed by some people, including scientists, who are not up to date with how 5G has evolved in the UK.

The second edition of the IET Guide "Allaying health concerns regarding 5G and exposure to radio waves" provides a bridge to understanding how the 5G technology being implemented and the frequencies being used affect radio wave exposure, compared to the earlier mobile technologies that everyone is very familiar with.

The Guide is also helpful in another respect. It brings together, in one publication, an explanation of the overall rigorous radio exposure safety framework for public mobile services, embracing both the mobile networks and smartphones. The conclusion that 5G is as safe as 4G, 3G and Global System for Mobile communication (GSM) is not a political soundbite, but a conclusion drawn from an objective detailed examination, by independent professional engineers, who belong to institutions committed to the very highest professional standards.

Professor Danielle George
IET Deputy President

Introduction

What is 5G?

5G is the next evolution in mobile technology that will provide the underlying wireless infrastructure to cope with the relentless rise in data consumption[1] and support many new applications. This includes everything from connected cars and virtual and augmented reality through to the foundations for emerging smart city and Internet of Things (IoT) technologies. It delivers this through the use of revolutionary new hardware like beam forming antennas and innovative new radio coding software at its core.

Features of 5G

Faster download speeds

It is expected that 5G will provide Gb/s data speeds. This would mean things that currently take minutes to download would only take seconds. Even more important will be the ability to support higher download speeds for many more concurrent users in the same place. This will lead to a more predictable and consistent performance.

Lower latency

5G can support significantly lower latency, where appropriate, meaning very little lag, or buffering. This could enable mobile applications that simply aren't possible today, such as multiplayer gaming, factory automation and other tasks that demand quick responses.

Greater capacity

5G will also have vastly greater capacity, allowing networks to better cope with not only the rapidly increasing data demands of customers today, but also the growth of high-demand applications being planned in the future.

[1] Ofcom "*Enabling 5G in the UK*" https://www.ofcom.org.uk/__data/assets/pdf_file/0022/111883/enabling-5g-uk.pdf.

Key observations

The 5G technology itself, ***in so far as it affects radio wave exposure***, is very similar to 4G and in terms of its pulsed signals, the same as Global System for Mobile communication (GSM), Digital Enhanced Cordless Telecommunications (DECT) phones and a version of 4G.

As there has been no dispensation for 5G safety standards, it will have to meet the same safety standards as 4G, 3G and GSM, meaning ***5G will be just as safe as 4G, 3G and GSM***.

There are no "higher frequency" (mmWaves) commercial 5G mobile antennas ***deployed anywhere in the UK*** and none are currently planned (due to high cost of coverage).

Reducing exposure to radio waves in the future requires more base stations ***in order to drive down both*** smartphone and base station power levels.

Electromagnetic Field (EMF) exposure guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP)

The first element of the cellular mobile radio wave exposure safety framework are the international recommended guidelines set by the ICNIRP at levels to ensure no harm[2].

The most recent set of ICNIRP guidelines were published on the 11th March 2020, following a comprehensive assessment of peer-reviewed scientific literature over two decades, covering both thermal and non-thermal effects. The guidelines are designed to ensure that all people are not exposed to electromagnetic radiation at radio frequencies[3] in a way that would have any adverse effect on the body, such as excessive heating. No evidence for cancer, infertility or other health effects[4] has been found at the exposure levels recommended in the guidelines.

The reference exposure level for bands below 6 GHz (i.e. all the frequencies currently used in the UK for GSM, 3G, 4G & 5G) has not been changed in the revised guidelines. They have been calculated by reference to specific absorption rate (SAR)[5] and incorporate a substantial margin of safety.

For bands above 6 GHz, where the body does not really absorb the Radio Frequency (RF), the guidelines are set by reference to Power Density (PD)[6], and again incorporating a substantial margin of safety.

[2] https://www.icnirp.org/en/frequencies/radiofrequency/index.html. https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf.

[3] The radiofrequency ranges are in the non-ionising part of the Electromagnetic Spectrum (30Hz to 300GHz), well below, for example, the visible light portion of the Electromagnetic Spectrum (c.430-740THz).

[4] Other health effects mentioned include absurd theories linking 5G to Coronavirus.

[5] **SAR** is defined as the power absorbed per mass of tissue and has units of watts per kilogram (W/kg). SAR is usually averaged either over the whole body or over a small sample volume (typically 1g or 10g of tissue).

[6] **Power density** is the amount of power per unit area (Watts/M2).

Compliance with ICNIRP guidelines for 5G mobile broadband networks

The second element of the cellular mobile radio wave exposure safety framework is *compliance* of base stations with ICNIRP recommended limits.

Ofcom intends to introduce a new condition in spectrum licences that will require licensees to ensure that all Electric and Magnetic Fields (EMF) emissions from radio equipment in excess of 10 watts (effective isotropic radiated power) complies with the relevant levels for general public exposure from the ICNIRP Guidelines. It will ensure Ofcom is in a position to take appropriate enforcement action in the event of non-compliance with the ICNIRP Guidelines.

Ofcom has already carried out their own independent measurements on some deployed 5G base stations and verified their compliance with the guidelines[7].

As part of the process for obtaining planning consent for new 4G/5G sites and upgrades, each operator will continue to confirm compliance with ICNIRP guidelines[8].

[7] See https://www.comsoc.org/publications/ctn/truth-out-there-examining-science-around-5g-paranoia.
[8] See https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/mobile-wirelessbroadband/exposure-electro-magnetic-fields.

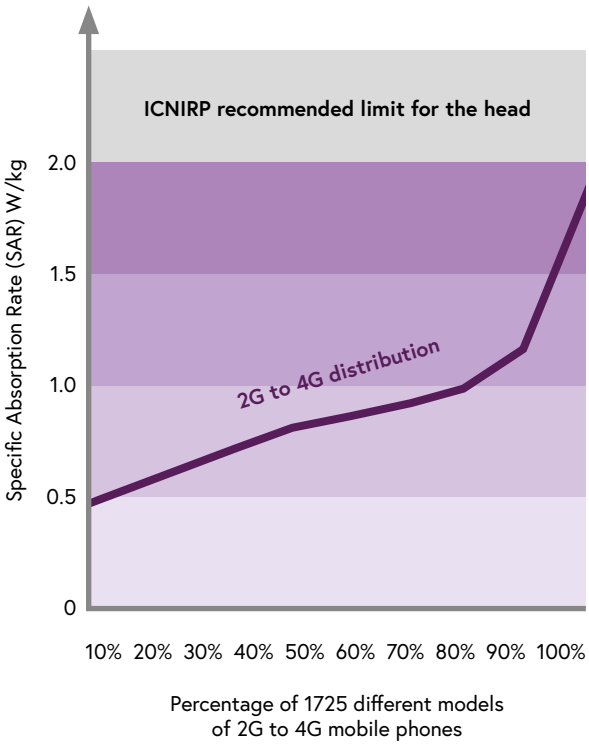
Compliance with ICNIRP guidelines for 5G smartphones and consumer choice

The third element of the cellular mobile radio wave exposure safety framework are the recommended limits for smartphones and other mobile devices.

A manufacturer, by adding a CE marking, is declaring, on its own responsibility, conformity with all of the legal requirements to achieve CE marking, including compliance with ICNIRP guidelines.

The illustration below indicates the distribution of Specific Absorption Rate (SAR) values for the head with GSM, 3G and 4G mobile technology generations based upon a very large sample of 1725 different models from 14 different manufacturers over a number of years.

Specific Absorption Rate (SAR) values for the head with GSM, 3G and 4G mobile technology



The result shows almost 80% of all models in this very large sample had SAR values under 50% of the recommended limit. Data has been gathered on a number of 5G smartphones on sale in the UK. All the values were compliant and comparable to the earlier generations of smartphones. The frequencies built into the UK 5G smartphones were all below 6 GHz.

In recent years, SAR information for some phones has not always been easy for consumers to locate. SAR information should be included in publicly available technical specifications of all smartphones in order to facilitate consumer choice.

Finally, "handsfree working" is now standard on all smartphones. This offers consumers the discretion for further reducing RF exposure.

Exposure level reductions from new masts and small cells

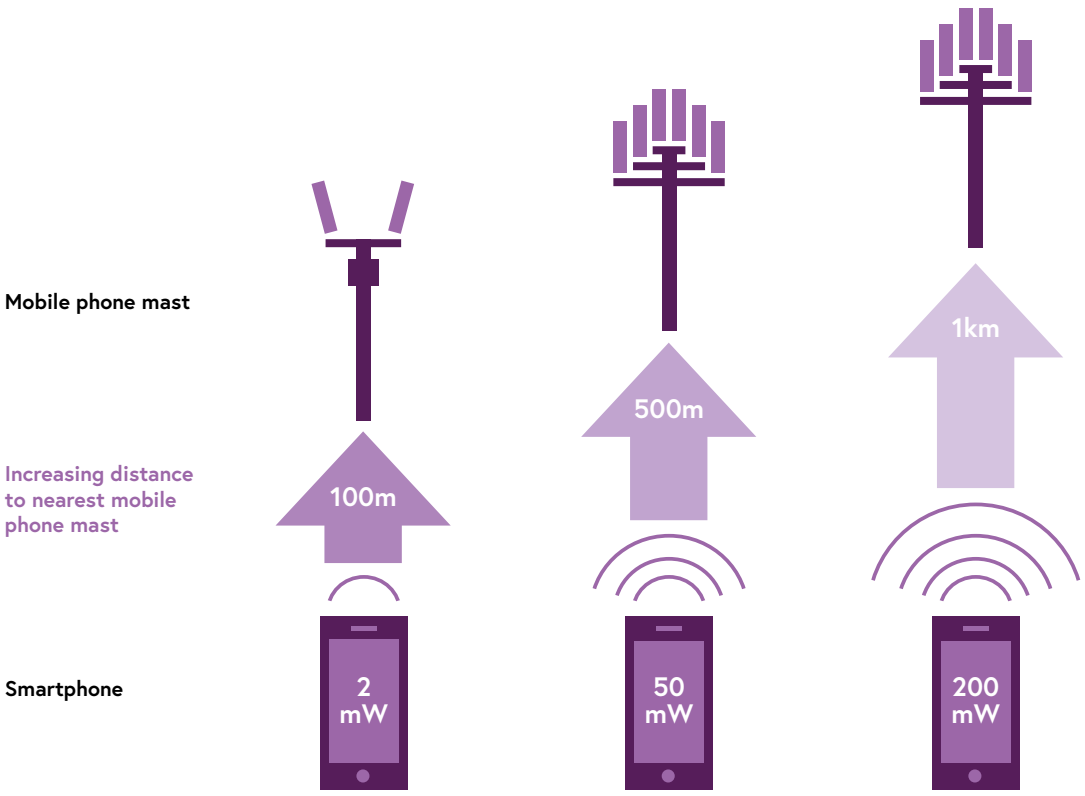
Small cells (micro-cells or pico-cells) are physically smaller antenna systems designed to work over a very short range to ease network congestion or fill in gaps in coverage.

Some people have expressed concern that a large number of 5G cells may increase a person's exposure to radio waves. However, that is not the way cellular mobile networks work. Every time a new mast or small cell is added, the distance the signal has to travel reduces. Therefore, from the laws of physics, the power needed at the smartphone and base station for a reliable connection is much less. Using the lowest practical power level is essential to prevent users located in different cells from disrupting each other's connections. It also saves the user's smartphone battery life.

For many people, their smartphone will be by far the nearest source of radio wave energy to them. As a result, more masts or 5G small cells will lead to a reduction in the overall radio wave signal strength an individual smartphone user is exposed to.

At the moment, there are relatively few small cells in use in the UK and though their numbers are likely to increase over time, we don't expect a mass rollout of them any time soon.

Illustrating how more base stations reduce smartphone powers and hence RF exposure[9]



[9] The numbers are purely illustrative and the actual powers will be determined by many factors including, importantly, the physical distance but also the urban topology between the network antenna and the smartphone.

The most widely used 5G band in the UK will be 3.6GHz

The UK and Europe proposed the use of three bands for 5G[10]. These were termed the 5G pioneer bands and each had a different purpose.

700MHz

This band is to secure pervasive national coverage. It's likely to be deployed from the traditional tall mobile phone masts. Only modest data capacity can be supported.

3.6GHz (3.4-3.8GHz)

The 3.6GHz band sits between the current WiFi bands at 2.4GHz and 5GHz that are already widely deployed in homes, offices and public places. 3.6GHz is the 'sweet spot' for achieving the best capacity over the largest areas for the lowest cost and has wide international support. The mass deployment of small low power base stations in towns and cities will most likely use this band[11].

26GHz

This high frequency (mmWaves) supports the largest capacity but at the highest cost of coverage. There are no 26 GHz (mmWaves) commercial 5G mobile antenna being deployed anywhere in the UK and none are currently planned.

Research engineers see a potential for 26GHz to be used for a data capacity lift in the limited number of locations where the 3.6 GHz frequency maxes out over the next 10 years (less than 3% of the UK[13]). Another use may be as a low power advanced manufacturing broadband access point (industry 4.0). Such examples of relatively short distance applications only need relatively low power levels.

Beam forming antennas

For the past 20 years mobile operators have typically used three or four sectored antennas, so as not to waste radio energy in directions where it's not needed. New beam forming antennas (sometimes referred to as Massive (complexity) Multiple input Multiple output antenna) make the transmission much more efficient, with the equivalent of 40, much smaller sectors, but still able to deliver the same power to a user standing at the edge of the cell's coverage area but wasting less energy to achieve this[12].

[10] European Commission Radio Spectrum Policy Group's "*Strategic Roadmap towards 5G in Europe*" https://rspg-spectrum.eu/wp-content/uploads/2013/05/RPSG16-032-Opinion_5G.pdf and IET "*5G Networks for Policy Makers*" report https://www.theiet.org/media/1166/5g-report.pdf.

[11] Ofcom "*Enabling 5G in the UK*" March 2018 paragraph 1.13 https://www.ofcom.org.uk/__data/assets/pdf_file/0022/111883/enabling-5g-uk.pdf.

[12] IEEE Spectrum "*5G Bytes: Massive MIMO Explained*" https://spectrum.ieee.org/video/telecom/wireless/5gbytes-massive-mimo-explained.

[13] techUK "*UK SPF publish principles for the release of 26 GHz 5G pioneer band*" https://www.techuk.org/insights/reports/item/15915-uk-spf-publish-principles-for-the-release-of-26-ghz-5g-pioneer-band.

Conclusion

5G is just as safe as 4G, 3G and GSM

This document has aimed to set out the reality around concerns regarding radio wave exposure, mobile coverage and 5G.

Small 5G base stations in our towns and cities will allow improved network coverage. They will reduce radio wave exposure to individual smartphone users and improve local 5G capacity for all manner of useful bandwidth-hungry applications. A good 5G fibre base local broadband infrastructure will be important to local communities over the coming decades in view of the ever-increasing amounts of data being consumed by the general public.

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