

Facts about 5G and Human Health

“Accelerating 5G Deployment in South Africa”

13 March 2024
Pretoria, South Africa

Dr Moshe Masonta



science & innovation

Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA



CSIR

Touching lives through innovation

Presentation Outline

1

The CSIR at a Glance

2

Electromagnetic Field (EMF) spectrum

3

Facts About 5G and Human health

4

South African position on 5G, environment and human health

5

Conclusion



The CSIR Mandate

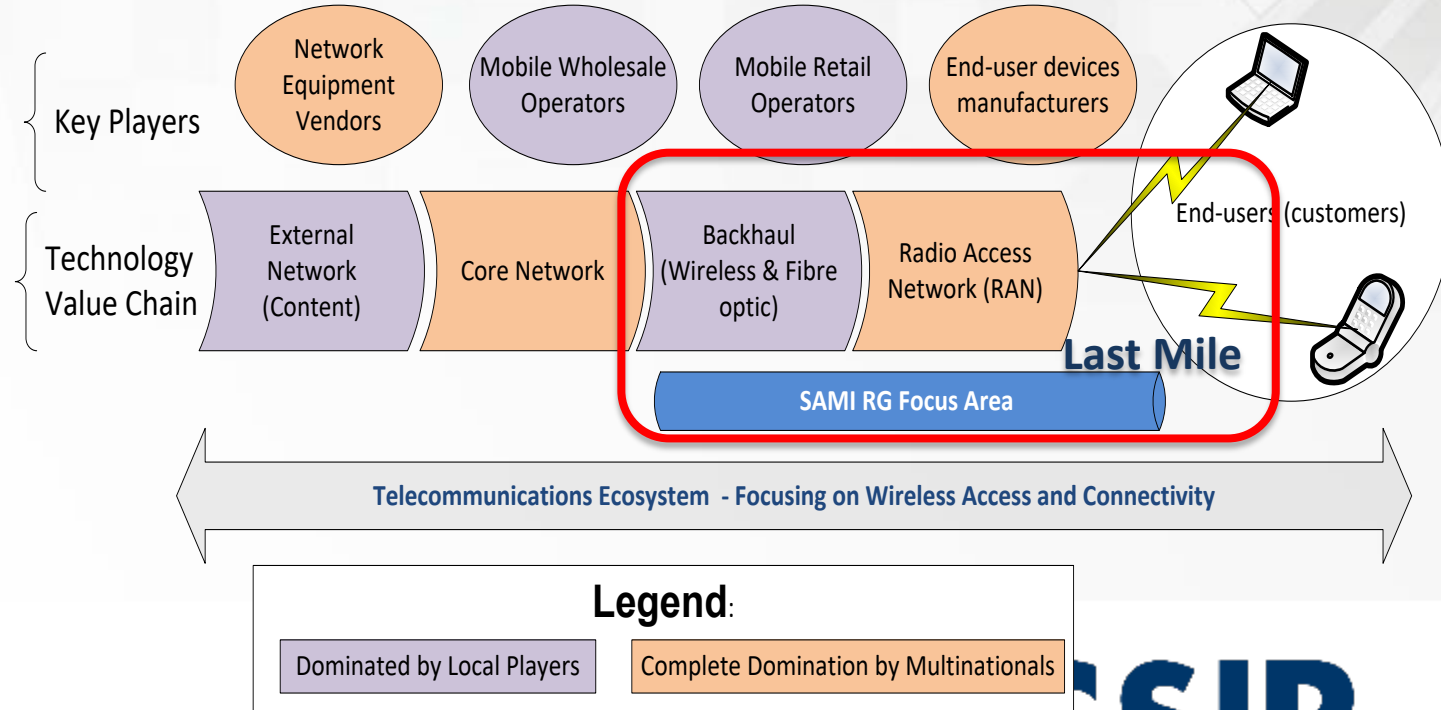
- “The objects of the CSIR are, through directed and particularly multi-disciplinary research and technological innovation, to foster, in the national interest and in fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with principals from the private or public sectors, and thereby to contribute to the improvement of the quality of life of the people of the Republic, and to perform any other functions that may be assigned to the CSIR by or under this Act.”

(Scientific Research Council Act 46 of 1988, amended by Act 71 of 1990)

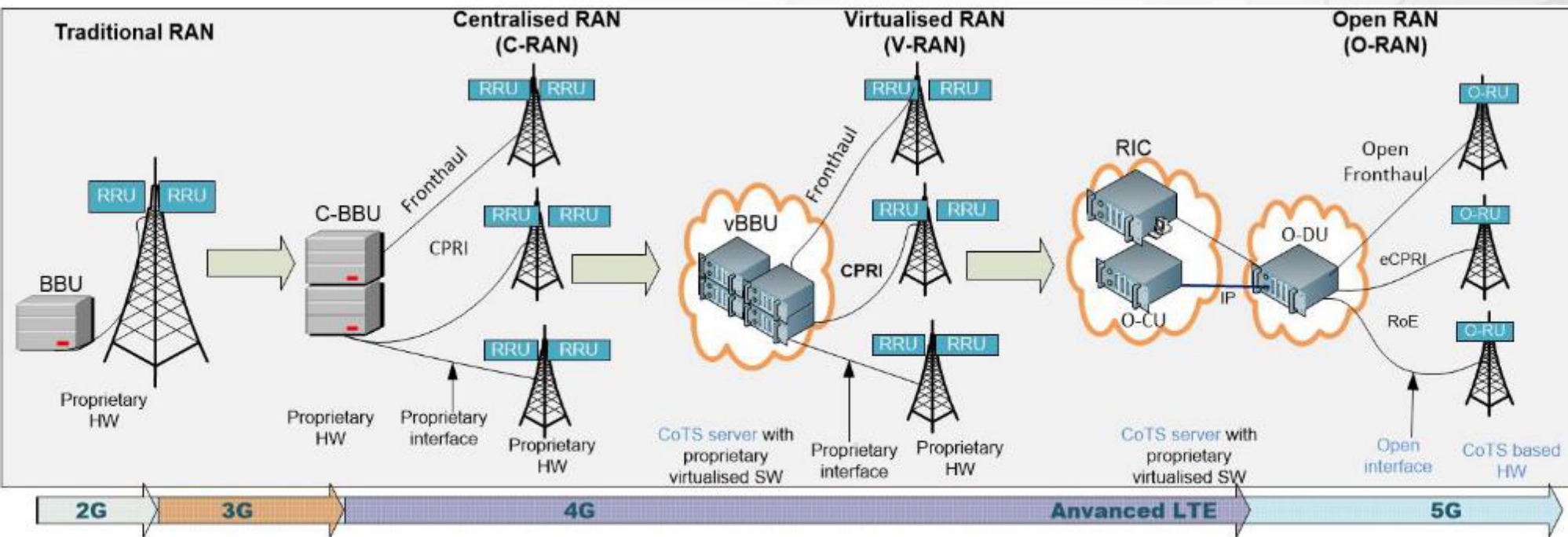
- CSIR was established through an Act of Parliament in 1945
- We are a leading scientific and technology research organisation that:
 - Researches, develops, localises and diffuses technologies,
 - Accelerates socioeconomic prosperity in South Africa.
- Our work contributes to industrial development and supports a capable state
- CSIR’s executive authority is the Minister of Higher Education, Science and Innovation
- More information: <https://www.csir.co.za/>

Spectrum Access and Management Innovation RG's position in the Telecoms sector

- Conducts RDI on **emerging and transformative technologies** in the wireless communication and connectivity ecosystem
- Our key driver: **Finding innovative solutions to efficiently manage RF spectrum and to provide broadband connectivity for all**
- We develop technologies that will enable South Africa's re-industrialisation through:
 - SMME support
 - Working with regulatory and policy makers
- Our vision is to lower the barriers to entry and reduced ICT imports by using innovative and open technologies



Evolution of mobile technology towards open RAN



BBU: Baseband Unit
HW: Hardware
SW: Software
IP: Internet Protocol

C-BBU: Centralised BBU
RAN: Radio Access Network
RoE: Radio over Ethernet
RIC: RAN Interface Controller

O-CU: Open Centralised Unit
O-RU: Open Radio Unit
O-DU: Open Distributed Unit
O-RAN: Open Radio Access Network

CoTS: Commercial of The Shelf
CPRI: Common Private Radio Interface
C-RAN: Centralised Radio Access Network
RRU: Remote Radio Unit (also Radio Remote Head: RRH)

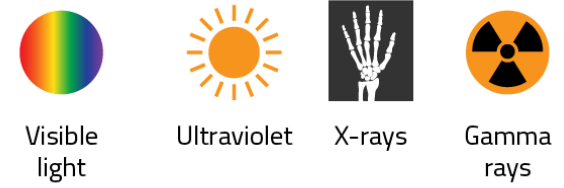
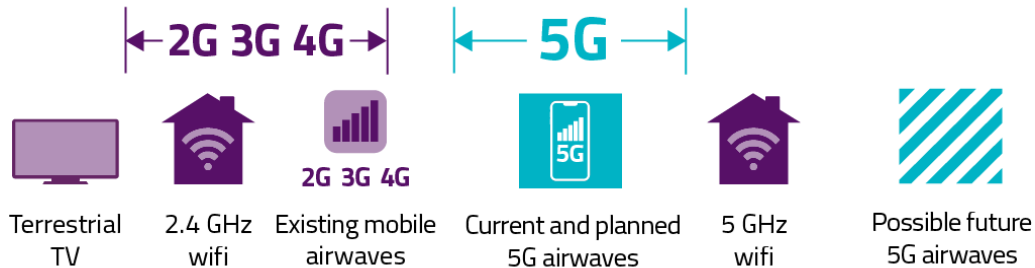
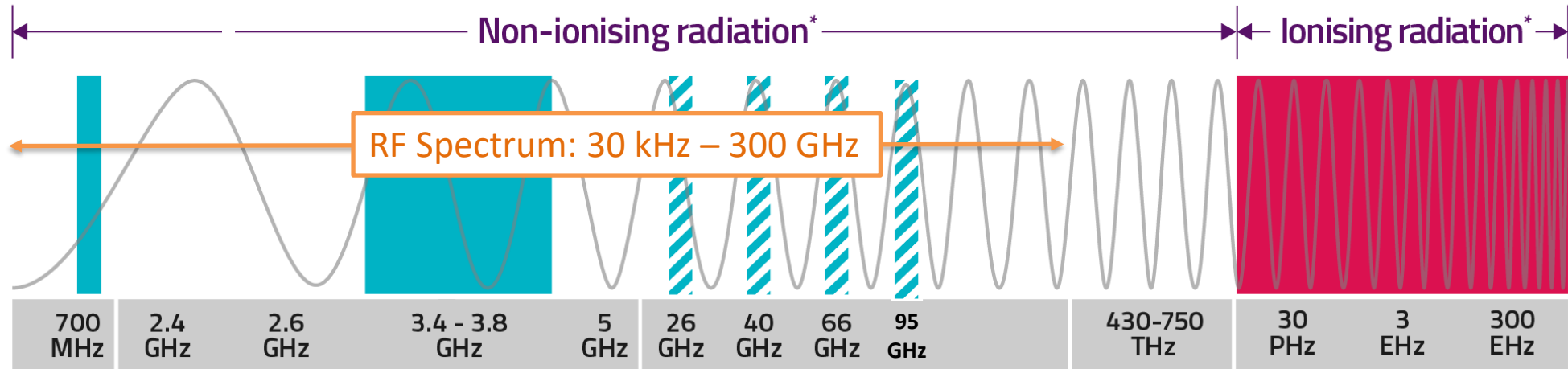
5G features:

- Cell densification (small cells)
- Massive MIMO
- Beamforming
- Adoption of mmWaves
- mMTC (million devices)

The background is a dark blue gradient with abstract, light blue geometric patterns. These patterns include overlapping circles, lines, and dots, creating a complex, network-like structure. The overall aesthetic is modern and technical.

Radio Frequency Electromagnetic Field (EMF) Spectrum

The Electromagnetic Field (EMF) spectrum



Hertz (Hz) key:
 kHz: kilohertz = 10^3 Hz
 MHz: megahertz = 10^6 Hz
 GHz: gigahertz = 10^9 Hz
 THz: terahertz = 10^{12} Hz
 PHz: petahertz = 10^{15} Hz
 EHz: exahertz = 10^{18} Hz

Source: Ofcom

**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)*

Non-ionising radiation

- Not enough energy to ionize the cells (i.e. cannot break chemical bonds or cause changes to cells in the human body)
- However, prolonged exposure above the threshold (set limits) can provoke some health effects,
- Power levels are regulated to protect human

Ionising radiation

- Enough energy to remove electrons from atoms in cells
- Exposed cells can either die or become cancerous
- Poses a risk for health effects

Research on RF EMF Safety

- Research on RF EMF exposure has been a fundamental challenge for cellular network deployment since the beginning of mobile technology [aa]
- **Two categories for research on RF EMF safety requirements [bb]:**
 - a) Epidemiological and experimental research:** into the interaction of biological organisms with electromagnetic fields
 - Conducted across the RF spectrum band for over 40 decades, and still ongoing
 - **Findings:** RF EMF exposure does not lead to adverse effects on public **health if it is below the recommended limits**
 - Such limits are set by international bodies, including the UN World Health Organisation (WHO)
 - b) Technical compliance assessment methods of exposure levels in deployed networks**
 - Based on theoretical calculation methods, measurements of RF EMF emitted by mobile networks, and
 - other methods being developed by academia & standardization bodies



[aa] Persia, S., Carciofi, C., Barbiroli, M., Volta, C., Bontempelli, D., & Anania, G. (2018, September). Radio frequency electromagnetic field exposure assessment for future 5G networks. In *2018 IEEE 29th Annual International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC)*

[bb] Chountala, Chrysanthi, Jean-Marc Chareau, and Pravir Chawdhry. "Radio frequency electromagnetic field measurements in a commercial 5G network." *2021 IEEE 4th 5G World Forum (5GWF)*. IEEE, 2021.

RF EMF Protection Guidelines - Internationally

- Globally, ICNIRP and IEEE developed EMF exposure guidelines & defined exposure limits
- The ICNIRP is an independent non-profit group of experts:
 - ICNIRP: International Commission on Non-Ionizing Radiation Protection
 - Assess the state of knowledge about the effects of non-ionizing radiation on the health and well-being
 - Provide science-based advice to protect the public and workers (used in more than 80 countries)
 - Latest guidelines released in March 2020
 - The guidelines cover many applications such as 5G technologies, Wi-Fi, Bluetooth, mobile phones, and base stations.

IEEE SA
STANDARDS
ASSOCIATION

IEEE Std C95.1™-2019
(Revision of IEEE Std C95.1-2005/
Incorporates IEEE Std C95.1-2019/Cor 1-2019)

This PDF contains IEEE Std C95.1-2019 and IEEE Std C95-2019/Cor 2-2020.

**IEEE Standards for Safety Levels with
Respect to Human Exposure to Electric,
Magnetic, and Electromagnetic Fields,
0 Hz to 300 GHz**

- IEEE is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity
- IEEE C95 is technology neutral
- Covers 5G, Wi-Fi, Bluetooth, mobile phones and mobile BS



RF EMF Protection at National Level



- About ICASA
- Consumer protection
- Licensing**
- Legislation/ regulations
- Market regulation
- News/ events
- Contact



- Spectrum & Type Approval Applications
- Consumer Complaints
- Complaints & Compliance Committee
- Numbering Portal

Home / Licensing / Type Approval

TYPE APPROVAL

In terms of section 35 (1) of the Electronic Communications Act, "No person may use, supply, sell, offer for sale or lease or hire any type of electronic communications equipment or electronic communications facility, including radio apparatus, used or to be used in connection with the provision of electronic communications, unless such equipment, electronic communications facility or radio apparatus has, subject to subsection (2), been approved by the Authority".

What is Type Approval?

"Type Approval" means a process by which Equipment or a device or system is authorized by the Authority to be used in South Africa or imported into South Africa and involves verification of the Equipment's compliance with the applicable standards and other regulatory requirements;

RF – EMF Safety

- Main metrics to characterise RF EMF exposure (defined by ICNIRP & IEEE):
 1. **Electromagnetic strength:** Each RF source generates an EMF that is spread over the environment
 2. **Power density (PD):** amount of power per unit area
 - Measures exposure in the far field (e.g. emitted by BSs)
 3. **Specific Absorption Rate (SAR) value** is a quantitative measure of power absorbed per unit of mass and time [W/kg].
 - Two SAR distinct values for:
 1. whole body SAR limits (exposure by BS) and
 2. local SAR limits (exposure by UE, e.g. head)

ICNIRP Guidelines • ICNIRP

Table 2. Basic restrictions for electromagnetic field exposure from 100 kHz to 300 GHz, for averaging intervals ≥ 6 min.^a

Exposure scenario	Frequency range	Whole-body average SAR ($W\ kg^{-1}$)	Local Head/Torso SAR ($W\ kg^{-1}$)	Local Limb SAR ($W\ kg^{-1}$)	Local S_{ab} ($W\ m^{-2}$)
Occupational	100 kHz to 6 GHz	0.4	10	20	NA
	>6 to 300 GHz	0.4	NA	NA	100
General public	100 kHz to 6 GHz	0.08	2	4	NA
	>6 to 300 GHz	0.08	NA	NA	20

Head SAR (EU), other Samsung models

Head SAR (EU) of Samsung Galaxy S23, data about other Samsung models with the same or similar head SAR values.

Samsung Galaxy Active Neo		0.928 W/kg
Samsung Galaxy S21 FE Exynos		0.93 W/kg
Samsung Galaxy Y Plus		0.938 W/kg

Apple iPhone 12 phone (A2403) Vs France authority Sep. 2023

	Initial value	Initial value	Value with update
System version	iOS 14.7.1	iOS 16.5.1 (C)	Mise à jour Apple / Firmware 4.06.02
« Head » SAR			
« Trunk » SAR	1,178 W/kg		
« Limb » SAR		5,74 W/kg	3,94 W/kg

It is now up to Apple to deploy this software update to all iPhone 12 users in order to bring the equipment in line with current standards. This will allow ANFR to lift the marketing ban.

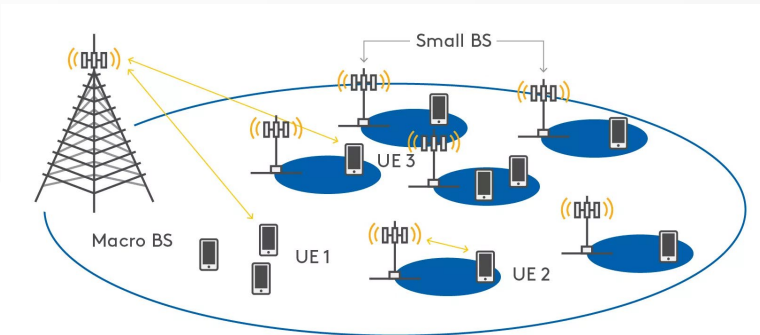
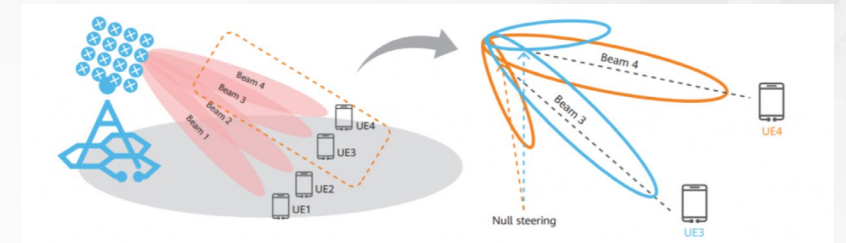
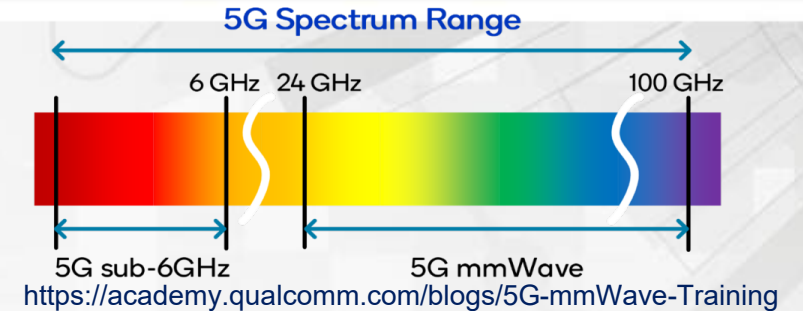


The background is a dark blue gradient with abstract, light blue geometric patterns. On the left side, there are several overlapping circles and a network of thin white lines connecting small dots, resembling a molecular or data structure. The overall aesthetic is clean, modern, and technological.

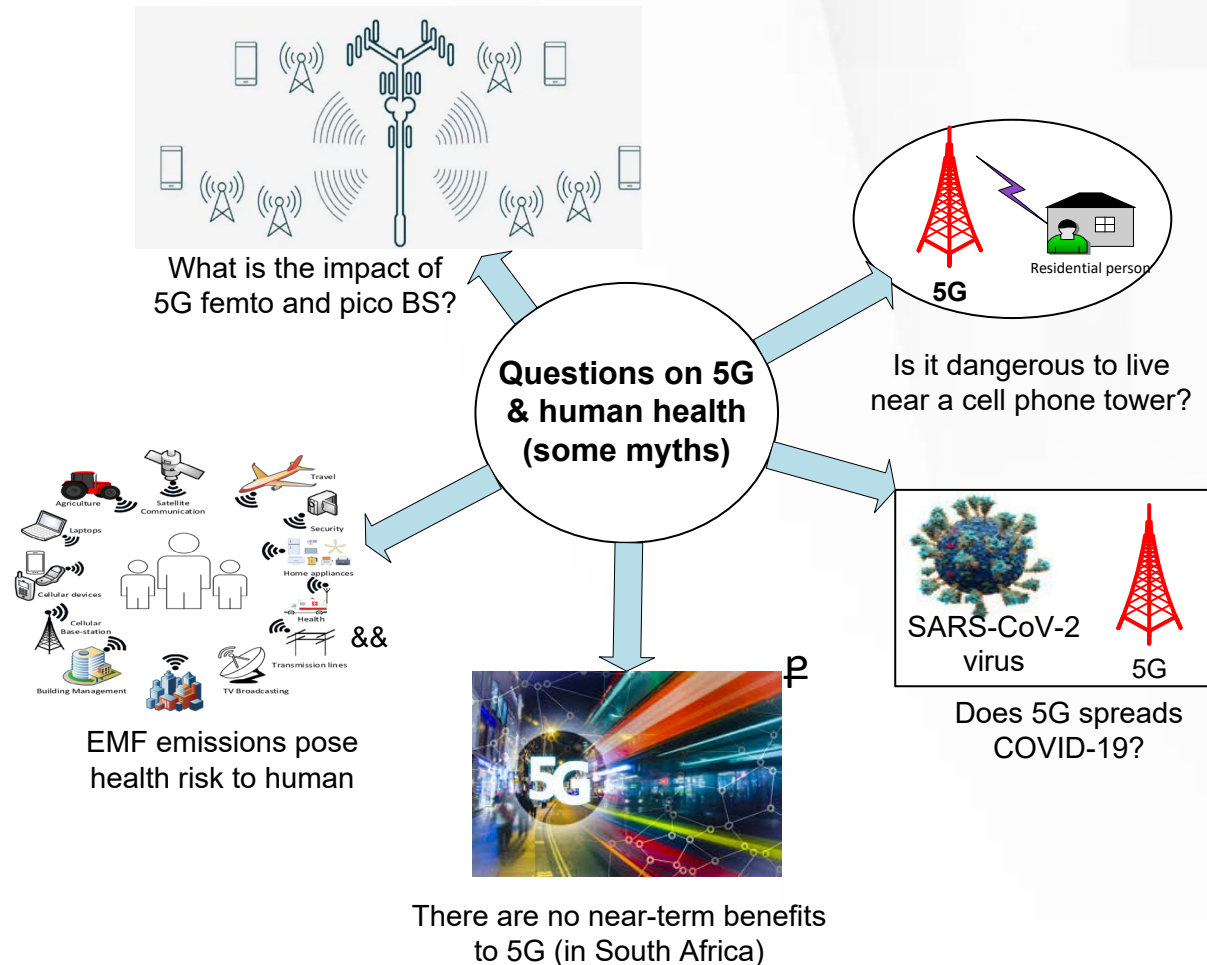
Facts about 5G and human health

Why 5G attracted more attention w.r.t human health?

- 5G met with resistance a few years before the year 2020
 - Several anti-5G campaigning organisations
- Three main concerns about 5G:
 - 1) Increased RF radiation exposure (higher frequencies)
 - 2) Multiple-input multiple-out (MIMO) & beamforming technologies
 - 3) Use of small cells
- However, COVID-19 made things worse
 - Propaganda networks show maps comparing 5G networks with COVID-19 infection rates.
 - Everyone became an expert.

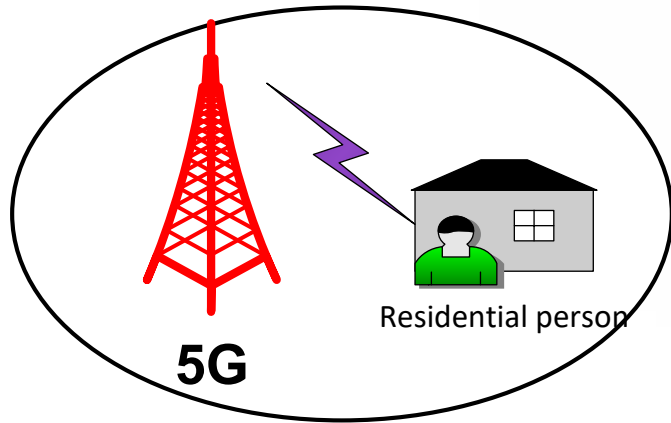


Some of the common questions we received about 5G & human health



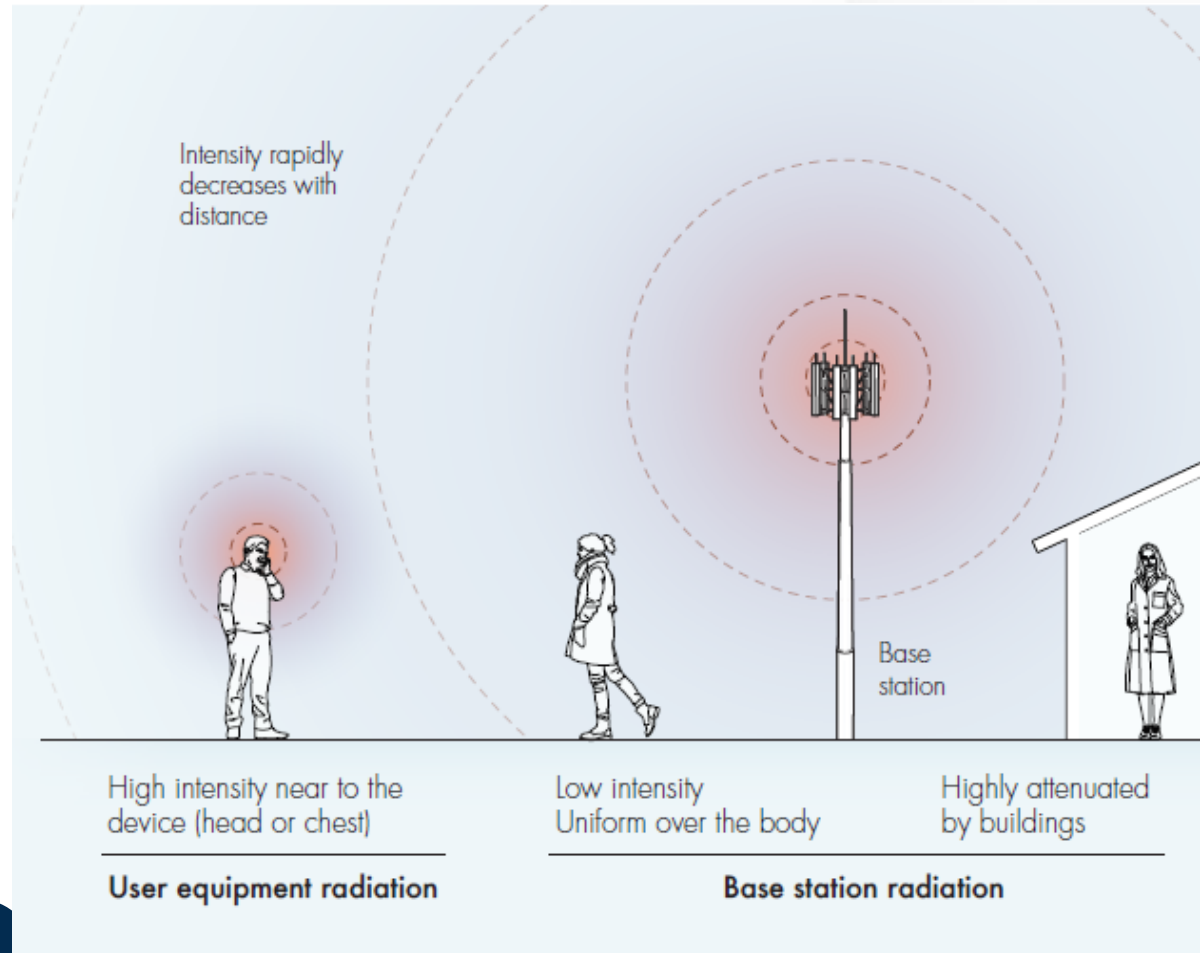
- 2020-21: speculations linking 5G to a range of health threats
- We received many queries from the media and public
- In response, we held media interviews (TV, radio & newspaper) and produced two documents to dispel some of the myths around 5G
 - “5G mobile telephony fact sheet: <https://www.csir.co.za/sites/default/files/Documents/5G%20Fact%20sheet.pdf>
 - “An assessment of claims regarding health effects of 5G mobile telephony networks: <https://www.csir.co.za/sites/default/files/Documents/5G%20Technical%20Article.pdf>
- These were outputs of a collaboration between **CSIR** radio engineering and health experts
 - *Not externally funded*

Q1: Is it dangerous to live near the cellphone tower?



- Radio signals drops as the square of the distance between the BS and mobile handset
- Compliance to health and safety is ensured by:
 - Controlling the transmit power level, adjusting the antenna tilt/pattern and restricting access to “unsafe” zones
- Ratio between the maximum permissible effective isotropic radiated power from the BS and the handset is about 40 dB (or 10 000 times)
 - Mobile phones can emit up to 23 dBm (around 200 mW) of power per band

Primary Sources of RF EMF Exposure in Mobile Networks



- **UE** EMF exposure:
 - Is higher compared to BS.
 - Is localised on the body (e.g. head).
- **BS** EMF exposure:
 - Source of continuous whole-body exposure
 - Rapidly decrease with distance (BS & users are >10x m apart)
 - Buildings add shielding effect
- **However**, the population associates higher health risks to BS emissions.

Q2: What is the health impact of 5G femto and pico BS?



- These are small cells, sometimes intended as “gap fillers” (e.g. picocell used in buildings like shopping malls)
- They are low-power devices, restricted to 0.1 – 1W transmission power,
- Studies found that power density (PD) can be reduced by a factor of 20 to 40 by using femto BSs instead of macro-BSs
- Like other communication devices, the safety of femto and pico BS is subject to the ICNIRP limits & type approval

Q3: There are no near-term consumer benefits to 5G (in South Africa)

These are some of the concerns we received:



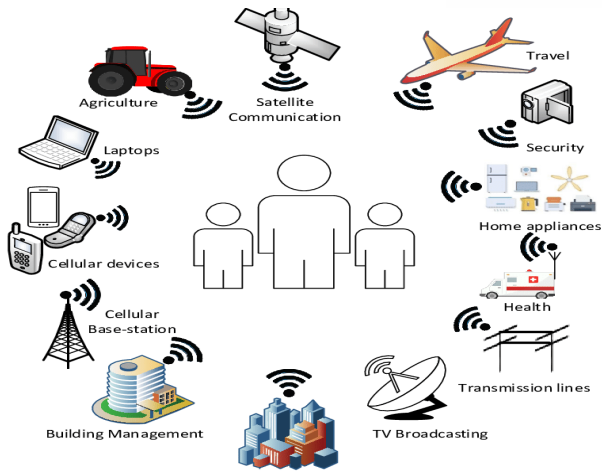
- Users are very happy with their current 4G service – why 5G?
- No reason for consumers to pay extra money to switch over to 5G!
- 5G will be all about businesses and not consumers
- No real use cases relevant for the consumer market
- Why do you need 5G in rural areas?

Our views:

We expect 5G to deliver more opportunities to consumers than its predecessors (education, health, e-government, entertainment)

5G is an enabler for our citizens to participate in the 4IR era

Q4: EMF emissions pose health risk to human



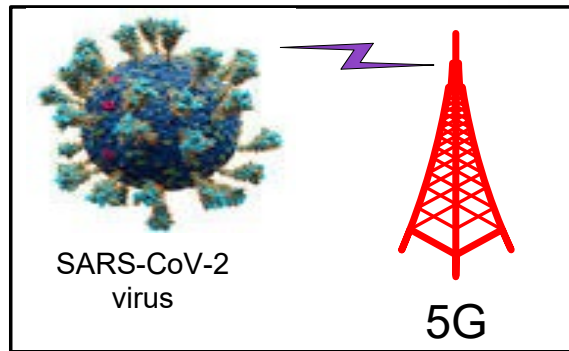
- We do not anticipate safety issues on 5G
 - Based on our understanding of the effects of radio signals on living organisms
- RF-EMF emission in 5G is closely regulated to ensure that users are safe
 - Just like with its predecessors (cellular have been used for over 40 years)
- 5G wireless networks are designed to be very efficient
 - 5G base stations will transmit low power (thanks to small cells)
- Extensive research on mmWave and health has been conducted on radar, microwave and military applications [**],
 - and more research is still going on globally

We agree with the WHO, ITU, EU and the ICNIRP's conclusion that exposure related to wireless networks and their use does not lead to adverse effects for public health if it is below the limits recommended by the ICNIRP



[**] T. Rumeng, S. Ying, W. Tong and Z. Wentao, "Electromagnetic field safety compliance assessments for 5G wireless networks," *2020 IEEE International Symposium on Electromagnetic Compatibility & Signal/Power Integrity (EMCSI)*, Reno, NV, USA, 2020, pp. 659-662. doi: 10.1109/EMCSI38923.2020.9191518.

Q5: Does 5G spreads COVID-19?



- 5G RFs are not high enough to break chemical bonds or remove electrons in human tissue
- It is highly unlikely that 5G may cause mutations in the SARS-CoV-2 virus in-vitro or in-vivo
- However, even if it did cause mutations under carefully controlled laboratory conditions in-vitro,
 - this would not be relevant in the real world, as the mmWave signals used by 5G do not significantly penetrate beyond the skin
 - 5G signal cannot influence the virus, as the virus replicates internally

The background is a dark blue gradient with abstract, light blue geometric patterns. These patterns include overlapping circles, lines, and a grid-like structure, suggesting a digital or technological theme. The overall aesthetic is clean and modern.

South African Government's Position on 5G, Human Health & the Environment

South African government's position

Question to RSA National Assembly



Ref: O2/1/5/2

NATIONAL ASSEMBLY
(For written reply)

QUESTION NO. 79 (NW82E)
INTERNAL QUESTION PAPER NO. 1 of 2021

DATE OF PUBLICATION: 11 February 2021

Mr N Singh (IFP) to ask the Minister of Forestry, Fisheries and the Environment :

In light of section 24 of the Constitution of the Republic, 1996, which guarantees the right to every person to an environment that is not harmful to their health or wellbeing and therefore do not subject any person to pollution or ecological degradation, what are the full relevant details of the steps that her department has taken in the Republic to ensure that the roll-out of 5G technology is not harmful to humans and the environment?

“... what are the full relevant details of the steps that her department has taken in the Republic to ensure that the roll-out of 5G technology is not harmful to humans and the environment?”

DEFF's response on mobile towers and the environmental issues:

In line with Section 24(2)(a) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), the Department has considered all the potential significant impacts associated with cellular masts on the receiving environment. Currently the development of masts or towers used for telecommunication broadcasting or radio transmission purposes has been identified as an activity requiring environmental authorisation, but only where such masts or towers:

- a. exceed 15 metres in height;
- b. are placed on a site not previously used for this purpose;
- c. are to be developed within certain specified geographical areas; and
- d. will not be attached to existing buildings, masts or rooftops.

Should the mast or tower not meet the above criteria, environmental authorisation is not required, as the potential impact of such developments are not deemed to be significant.

South African: Department of Health's response



Department of Health

Directorate
: Radiation

☎: 021 957 7483
Fax: 021 946 1589
E-mail: Leon.DuToit@sahpra.org.za

Enquiries: LL du Toit
Date: 13 June 2020

To whom it may concern

HEALTH EFFECTS OF CELLULAR BASE STATIONS AND HANDSETS

The Directorate: Radiation Control was the section within the National Department of Health that was responsible, from the viewpoint of human health, for regulating electronic products producing **non-ionising** electromagnetic fields (EMF), i.e. where the frequency of such EMF is less than 300 GHz. **The Directorate Radiation Control has since been transferred to the South African Health Products Regulatory Authority (SAHPRA).** In carrying out its responsibility, the Directorate has been utilising the World Health Organization's (WHO) International EMF Project (www.who.int/peh-emf/en/) as its primary source of information and guidance with respect to the health effects of EMF. The International EMF Project was established by the WHO in 1996 to (i) assess the scientific evidence for possible adverse health effects of non-ionising electromagnetic fields on an on-going basis, (ii) initiate and coordinate new research in this regard, and (iii) compile health risk assessments for different parts of the electromagnetic spectrum. The Department of Health has been a member of the International Advisory Committee of the International EMF Project since 1998.

In June 2005 the International EMF Project hosted a workshop that was specifically aimed at considering the possible health consequences of the emissions from cellular base stations and wireless networks. The findings of this workshop were summarised in a 2-page Fact Sheet (<http://www.who.int/peh-emf/publications/facts/fs304/en/>). The following extract from this Fact Sheet is still considered by the WHO as a summary of the findings to date,

i.e. "Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects."

Another WHO Fact Sheet was published in June 2011 and reviewed in October 2014, i.e. *Electromagnetic fields and public health: mobile phones*. This Fact Sheet can be found at <http://www.who.int/mediacentre/factsheets/fs193/en/>) and the conclusion is stated as follows:

"A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use."

The WHO recommends utilising internationally recognised exposure guidelines such as those published in 1998 by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and reconfirmed in 2009 for the frequency range 100 kHz – 300 GHz (i.e. including all the frequencies employed by the cellular industry). The Department of Health likewise recommends the use of these ICNIRP guidelines to protect people against the known adverse health effects of EMF.

South African: Department of Health's response

- Actual levels of public EMF exposure due to BS emissions are a fraction of the ICNIRP guidelines.
- “There is **no** confirmed scientific evidence that points to any health hazard ...”
- DoH is “satisfied that the health of the general public is not being compromised...”
- Local and other authorities “**do not need to and should not attempt to:**”
 - Set any restrictions with respect to parameters such as:
 - distance to the mast,
 - duration of exposure
 - height of the mast, etc.

The numerous measurement surveys, which have been conducted around the world and in South Africa, have shown that the actual levels of public exposure as a result of base station emissions invariably are only a fraction of the ICNIRP guidelines, even in instances where members of the public have been really concerned about their exposure to these emissions. At present there is **no** confirmed scientific evidence that points to any health hazard associated with the very low levels of exposure that the general public would typically experience in the vicinity of a cellular base station. The Department is therefore satisfied that the health of the general public is not being compromised by their exposure to the microwave emissions of cellular base stations. This also means that local and other authorities, in considering the environmental impact of any particular base station, do not need to and should not attempt, from a public health point of view, to set any restrictions with respect to parameters such as distance to the mast, duration of exposure, height of the mast, etc.

health of the person would be falling at any height from the structure in question. Based on the results of numerous global and local surveys, the experience has been that the exposure to base station EMF at ground level is typically in the range of between 0.001 – 1.0 % of the afore-mentioned ICNIRP guideline limits. Against this background of available data, there

Conclusion

- 5G RF EMF exposure is regulated by international and national organisations
- ICNIRP guidelines define levels of RF EMF exposure that are considered safe
 - Latest revision: March 2020
- IEEE C95.1 standard defines safety limits for protection of person on RF EMF
 - Latest revision: 2019
- The South African Health Products Regulatory Authority (SAPRA) is responsible for regulating electronic products producing non-ionising EMF
 - There are “no scientific grounds to support any allegation that adverse health effects might be suffered by a responsible member of the public due to the EMF emitted by a base station.”
- Prior to commissioning – a BS is tested by a specialised company that issues a compliance certificate
 - Similarly, mobile handsets are tested for type approval
- However, as the new networks become a part of the national plan, more epidemiological studies may have to be conducted to ensure that their operation does not result in health problems in the populace

The background is a dark blue gradient with abstract white and light blue geometric shapes, including circles, lines, and a grid pattern, creating a technical or scientific aesthetic.

Thank You

mmasonta@csir.co.za