

# Facts about 5G and Human Health

Dispelling myths around 5G

*“Accelerating 5G Deployment in South Africa”*

**06 September 2023**

Cape Town, South Africa

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**science & innovation**

Department:  
Science and Innovation  
REPUBLIC OF SOUTH AFRICA



**CSIR**

Touching lives through innovation

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# The CSIR Mandate

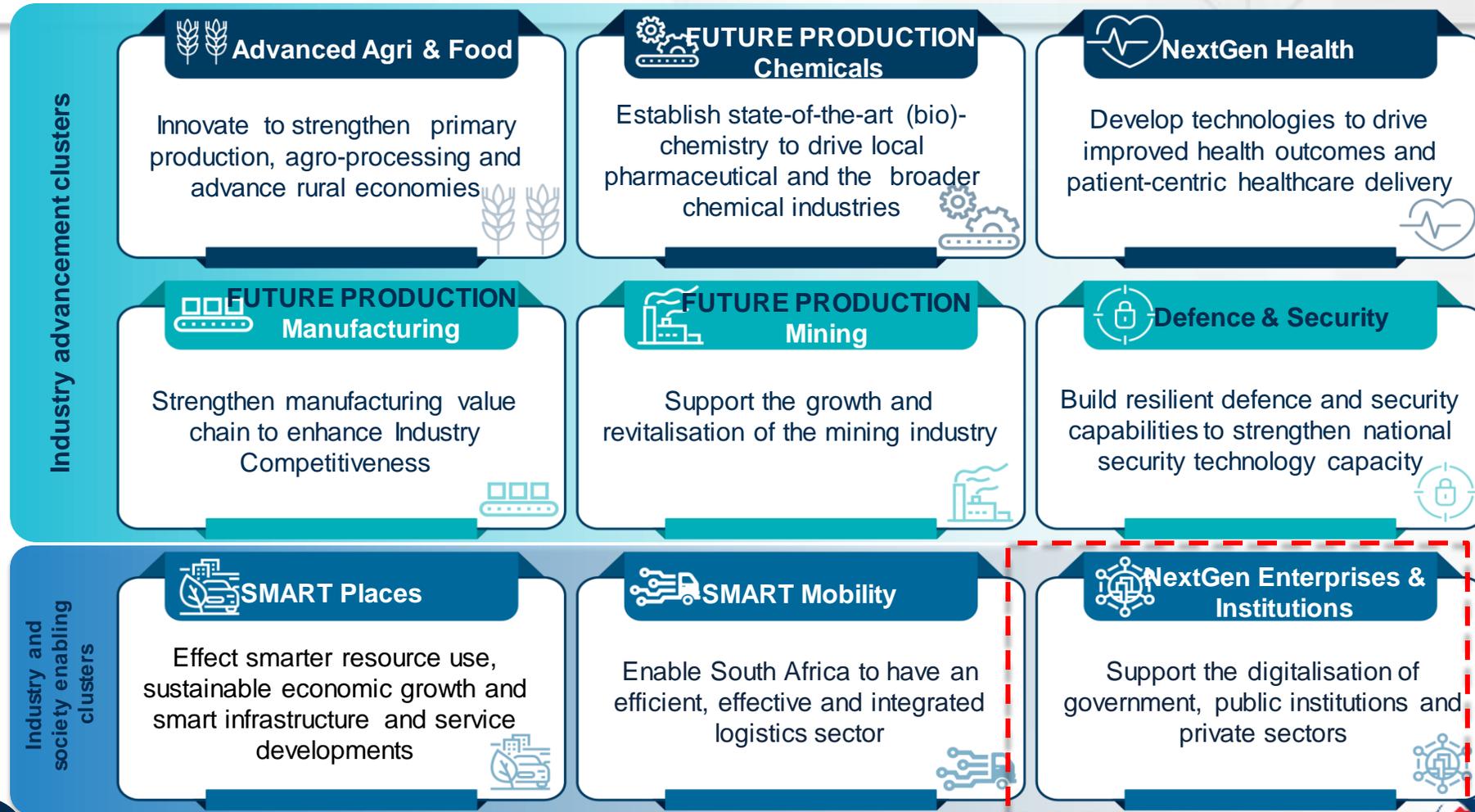
- “The objects of the CSIR are, through directed and particularly multi-disciplinary research and technological innovation, to foster, in the national interest and in fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with 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/>

# The pillars of the CSIR Strategy

## Positioned to drive SA's industrialisation

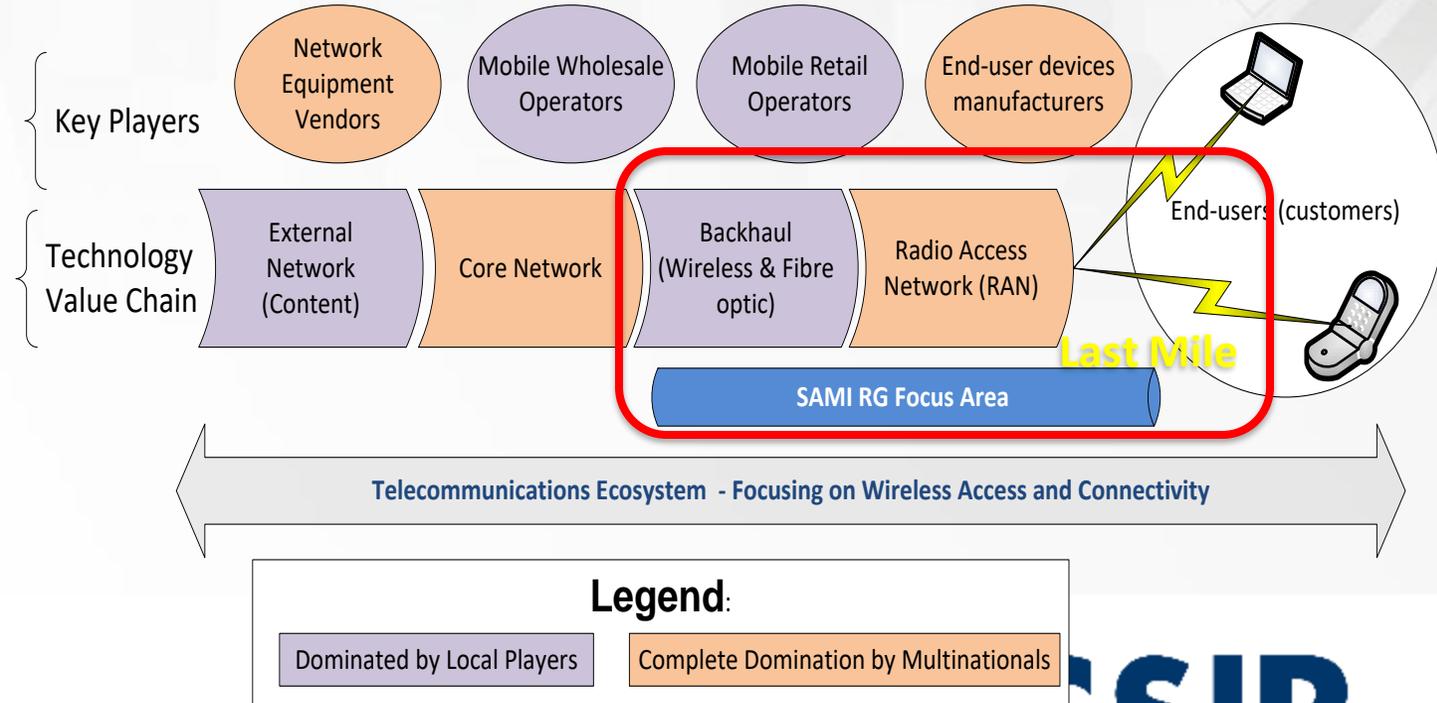


The clusters are technology industry convergences that represent the CSIR's strategic focus. They have been selected based on national priorities, potential for socioeconomic impact and the fourth industrial revolution.

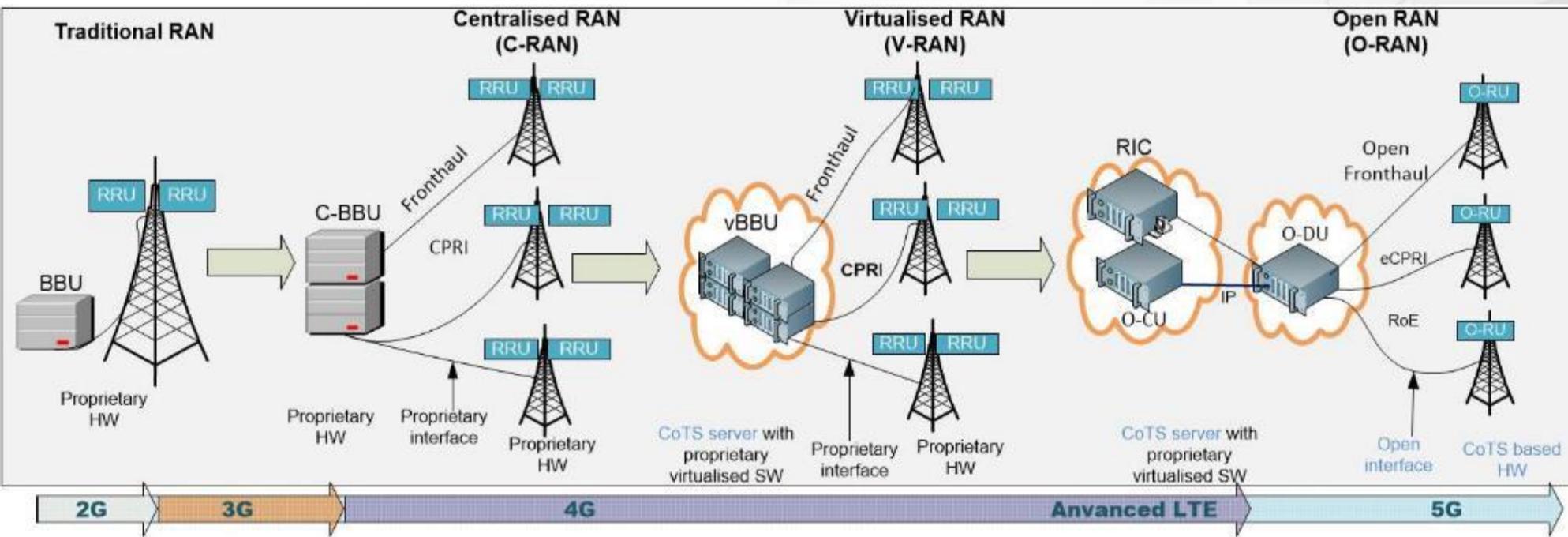


# Spectrum Access and Management Innovation RG's position in the Telecoms sector

- 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 viewed from RAN



## 5G features:

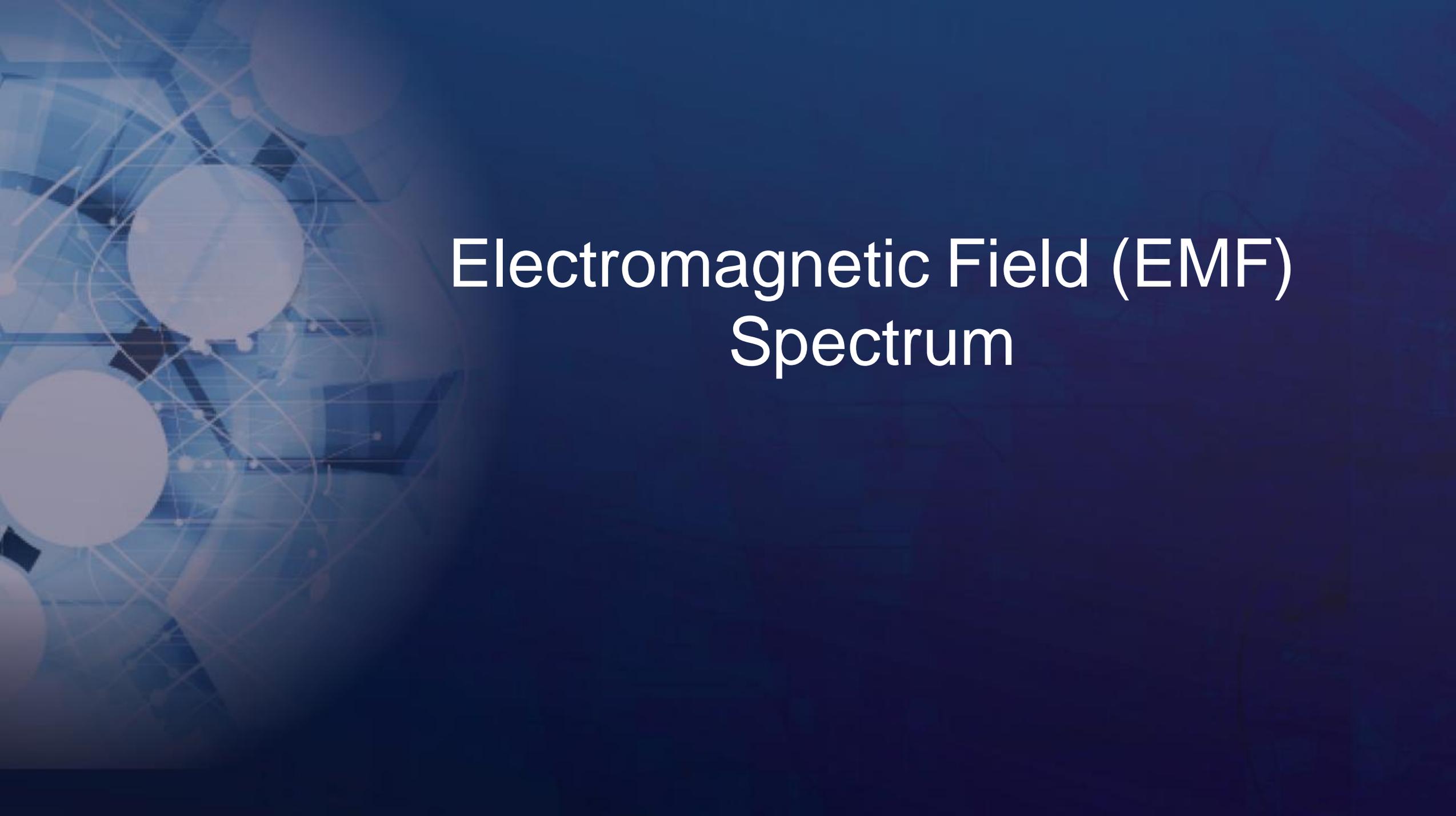
- Cell densification (small cells)
- Massive MIMO
- Beamforming
- Adoption of mmWaves
- mMTC (million devices)

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

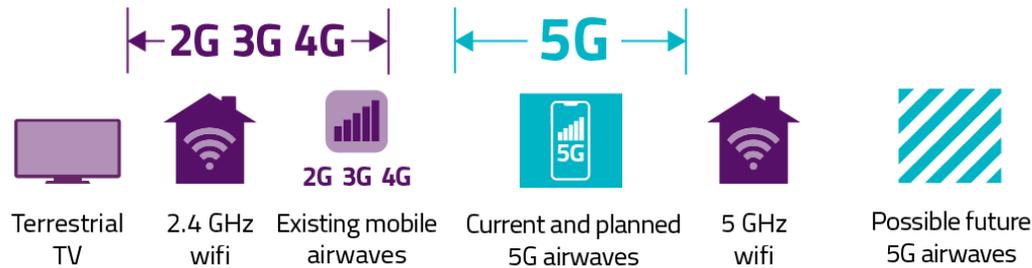
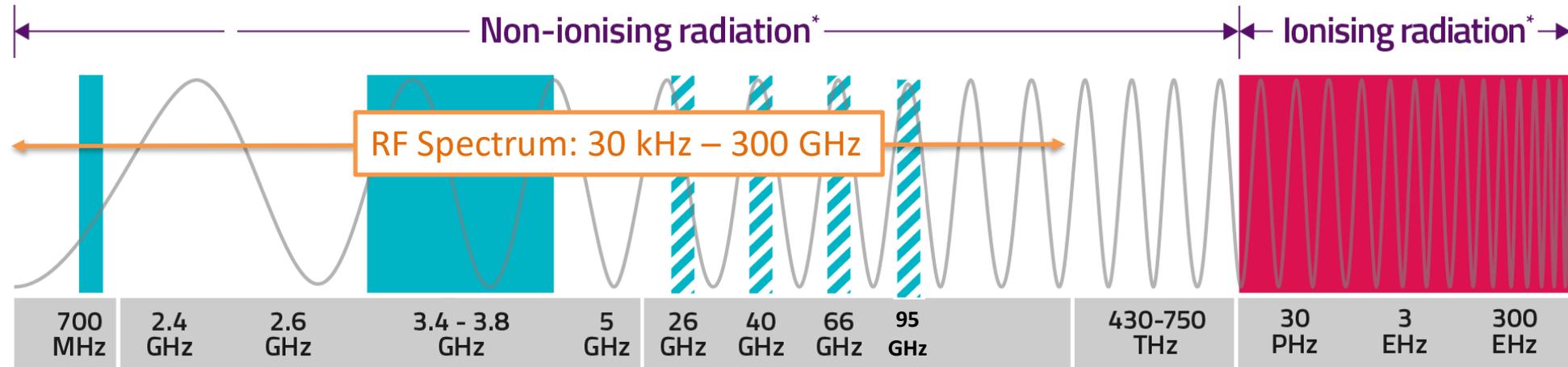
O-CU: Open Centralised Unit  
O-RU: Open Radio Unit  
O-DU: Open Distributed Unit  
O-RAN: Open Radio Access Network

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)

The background is a dark blue gradient with abstract, light blue geometric patterns. These patterns include overlapping circles, lines, and dots, creating a sense of depth and complexity. The overall aesthetic is modern and technical.

# Electromagnetic Field (EMF) Spectrum

# The Electromagnetic Field (EMF) spectrum



Hertz (Hz) key:  
 kHz: kilohertz =  $10^3$  Hz      THz: terahertz =  $10^{12}$  Hz  
 MHz: megahertz =  $10^6$  Hz      PHz: petahertz =  $10^{15}$  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
- Power levels are regulated to protect human
- Prolonged exposure, above threshold (set limits) can provoke some health effects
- Hence there are limits set by international bodies

### 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 the 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
    - Have been conducted across the RF spectrum band for over 40 decades, and still ongoing
    - Findings: RF EMF exposure does not lead to adverse effects for public **health if it is below the recommended limits**
    - Such limits are set by the International bodies, including the UN 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

- Globally, ICNIRP and IEEE developed EMF exposure guidelines & defined exposure limits
- The ICNIRP is an independent non-profit group of experts:
  - 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

INTERNATIONAL COMMISSION ON NON-IONIZING RADIATION PROTECTION



## ICNIRP GUIDELINES

FOR LIMITING EXPOSURE TO TIME-VARYING  
ELECTRIC, MAGNETIC AND ELECTROMAGNETIC  
FIELDS (UP TO 300 GHz)

**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)

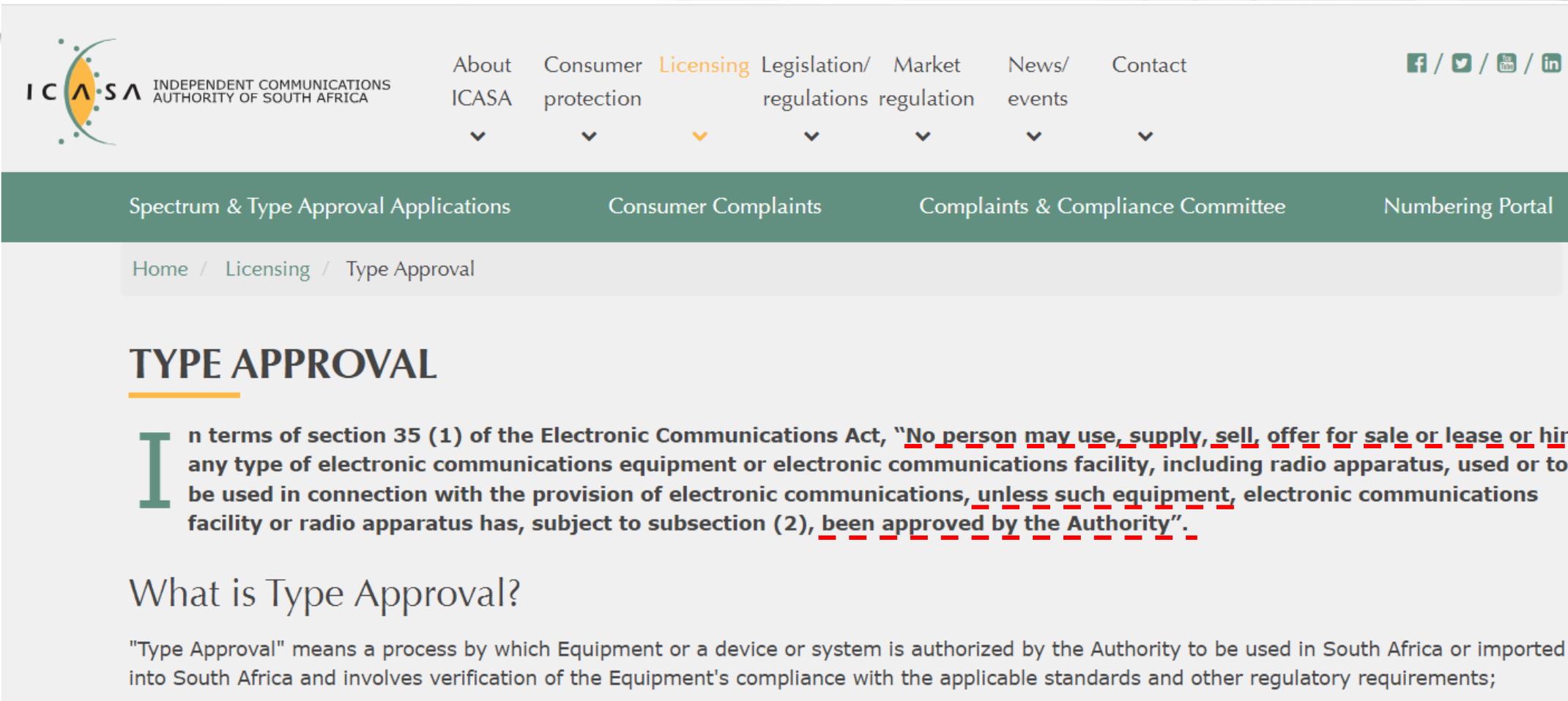
*This PDF contains IEEE Std C95.1-2019 and IEEE Std C95-2019/Cor 2-2020.*

**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



The screenshot shows the ICASA website header with navigation links: About ICASA, Consumer protection, Licensing (highlighted), Legislation/regulations, Market regulation, News/events, and Contact. Social media icons for Facebook, Twitter, YouTube, and LinkedIn are also present. Below the header is a green navigation bar with links for Spectrum & Type Approval Applications, Consumer Complaints, Complaints & Compliance Committee, and Numbering Portal. The breadcrumb trail reads: Home / Licensing / Type Approval.

## TYPE APPROVAL

**I**n 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;

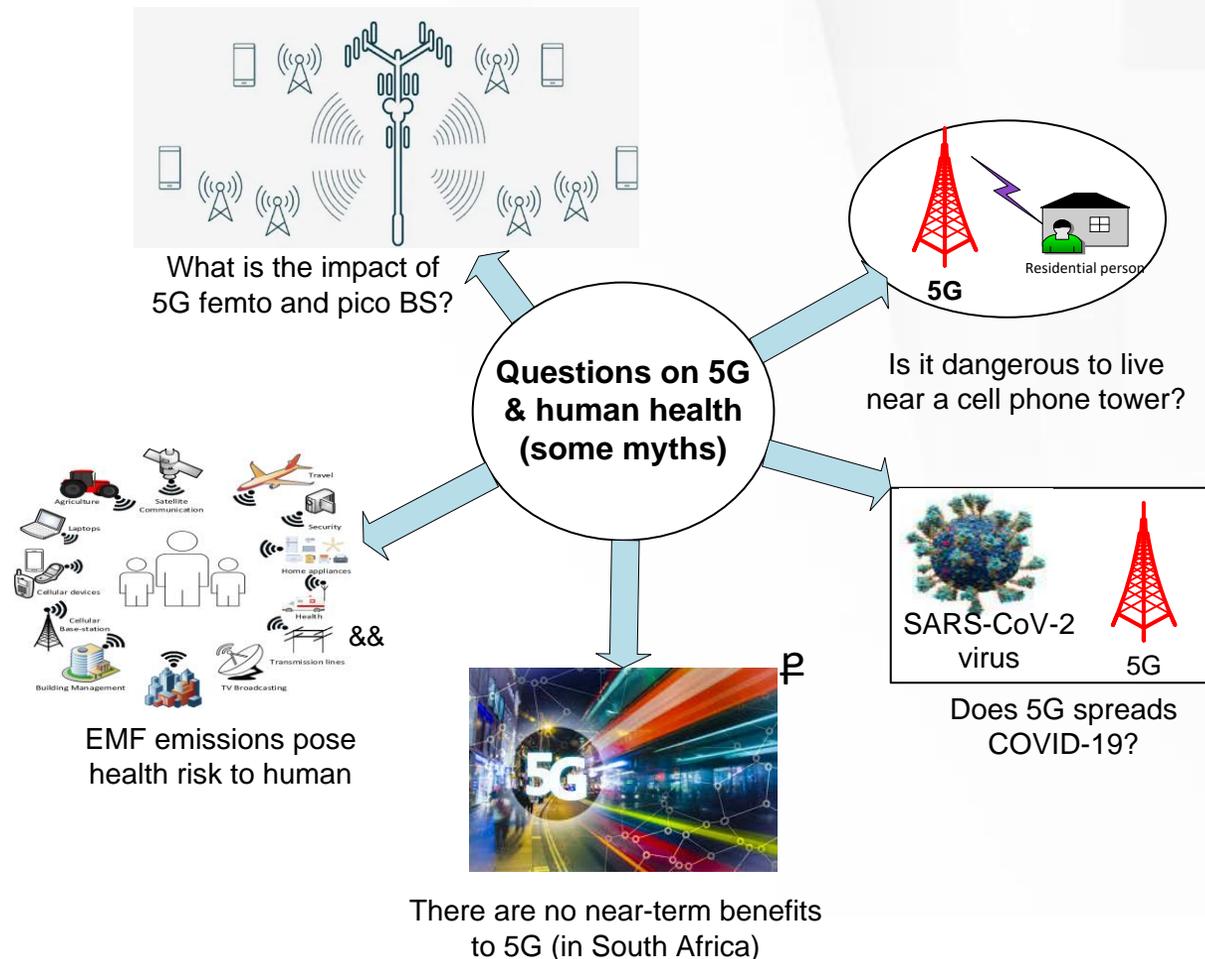
# A big question: Is 5G Safe?

- Main metrics to characterise RF EMF exposure (limits 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)
- **Answer: Yes, it is safe:**
  - Globally, there are strict standards and guidelines to protect humans from 5G RF EMF exposure
  - **National regulatory authorities** regulate the maximum transmit power levels allowed to minimise interference among users, and to meet **safety limits** (type approval)

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.

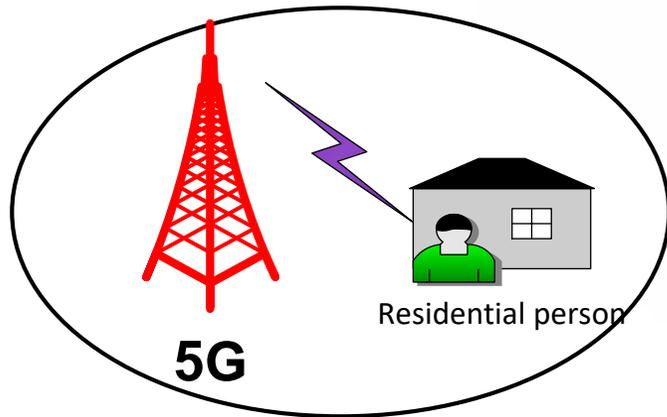
# Facts about 5G and human health

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



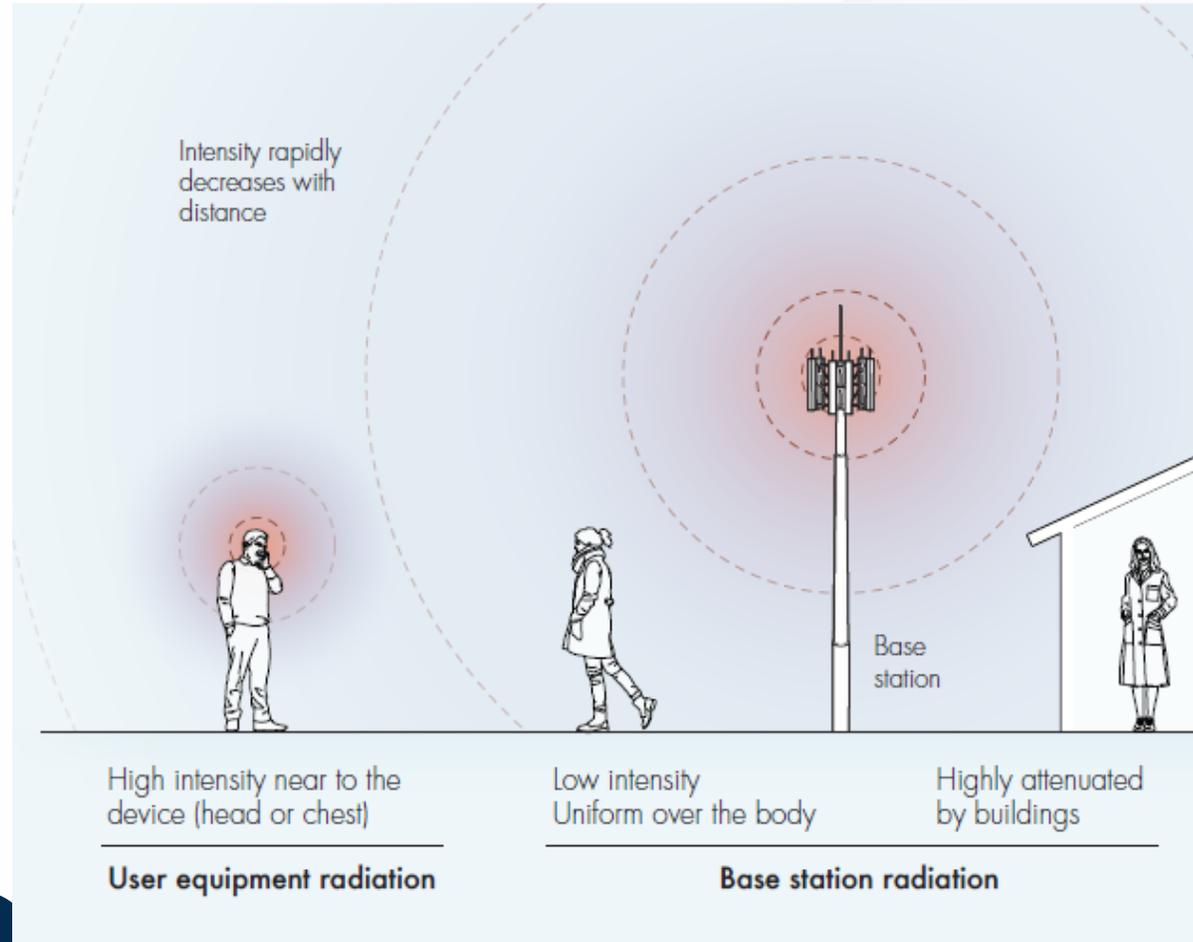
- 2020-21: speculations linking 5G to a range of health threats
- We received many queries from the media and public
- In response, we held media interviews (TV, radio & newspaper) and produced two documents to dispel some of the myths around 5G
  - “5G mobile telephony fact sheet: <https://www.csir.co.za/sites/default/files/Documents/5G%20Fact%20sheet.pdf>
  - “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 radio engineering and health experts

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



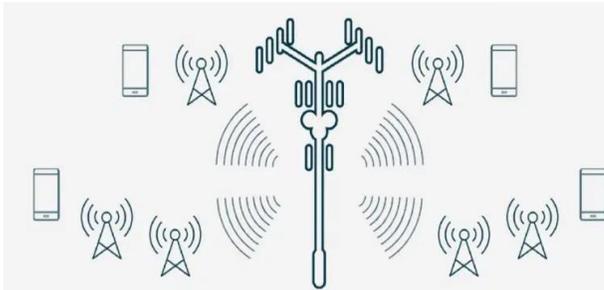
- Radio signals drops as the square of the distance between the BS and mobile handset
- Compliance to health and safety is ensured by:
  - Controlling the transmit power level, adjusting the antenna tilt/pattern and restricting access to “unsafe” zones
- Ratio between the maximum permissible effective 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:



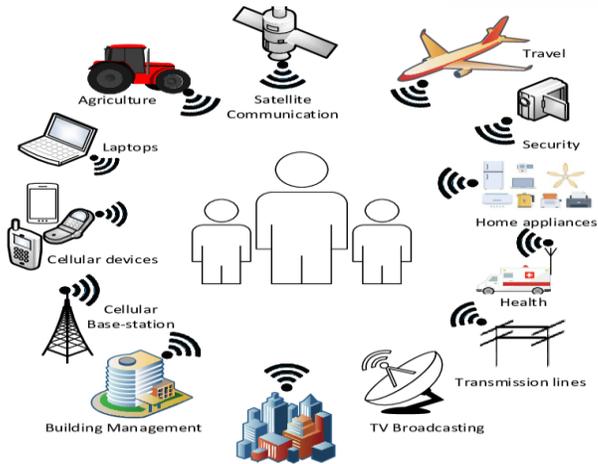
- Users are very happy with their current 4G service – why 5G?
- No reason for consumers to pay extra money to switch over to 5G!
- 5G will be all about businesses and not consumers
- No real use cases relevant for the consumer market
- Why do you need 5G in rural areas?

### 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

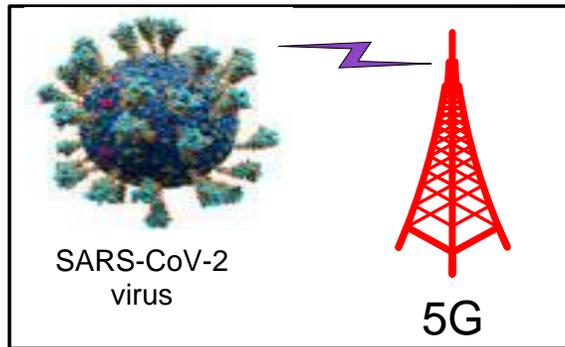


- We do not anticipate safety issues on 5G
  - Based on our understanding of the effects of radio signals on living organisms
- RF-EMF emission in 5G is closely regulated to ensure that users are safe
  - Just like with its predecessors (cellular have been used for over 40 years)
- 5G wireless networks 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



## 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

# 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
- RF EMF exposure regulations are intended to protect:
  - General public in unrestricted environments, and
  - Persons permitted in restricted environments (e.g. RF technicians).
- Prior to commissioning – a BS is tested by a specialised company that issues 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 modern, technical aesthetic.

# Thank You

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