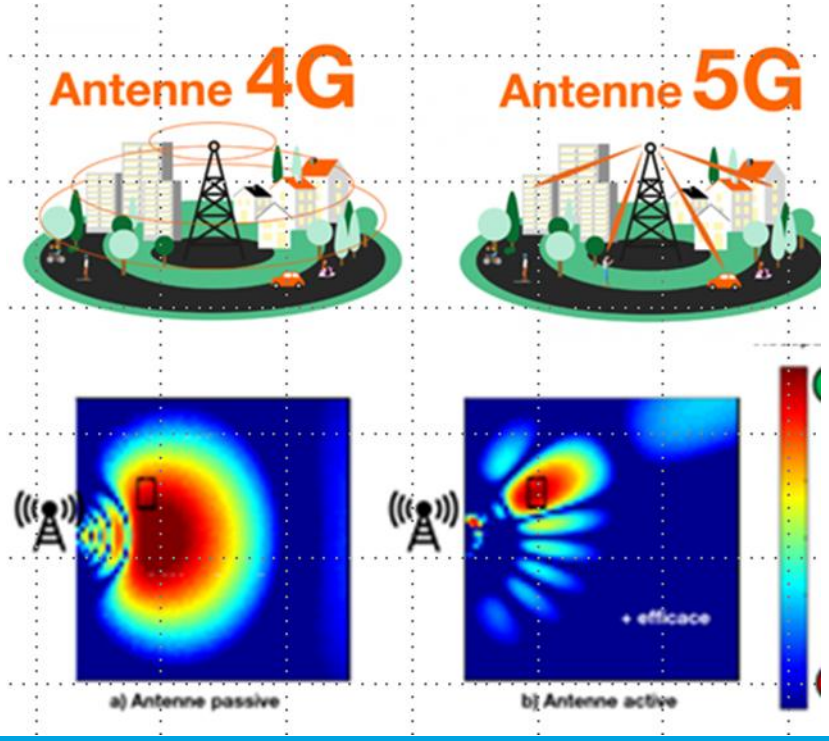
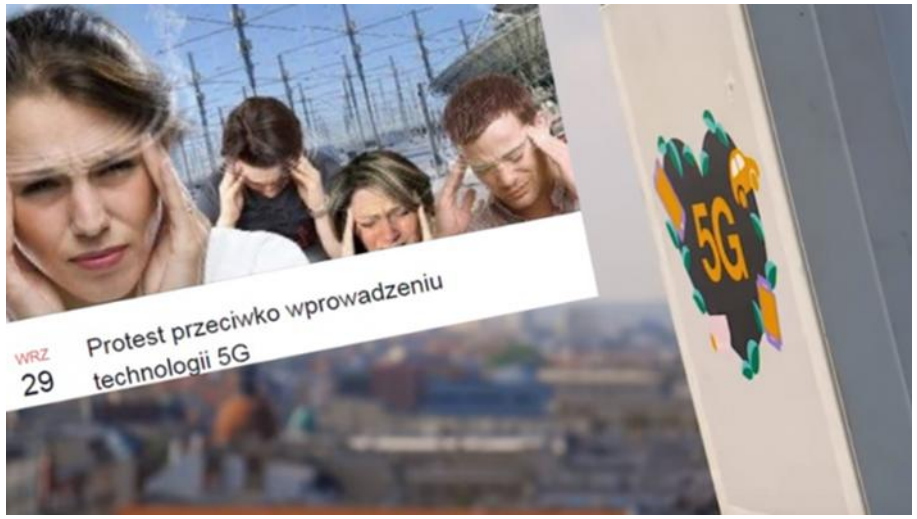
Workshop on EMF Harmony: International, Regional and National Policies, Strategies and Standards Related to Human Exposure to Electromagnetic Fields
Moldova, 23 September 2025

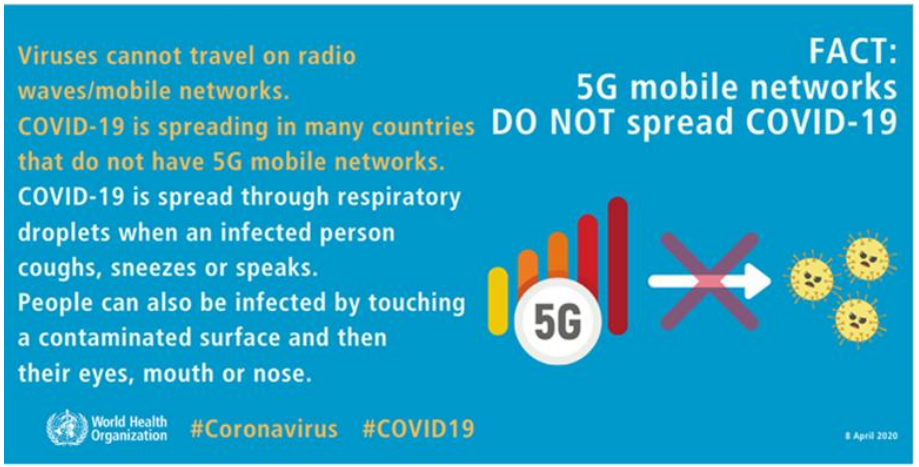
Setting the Context: Why EMF matters?

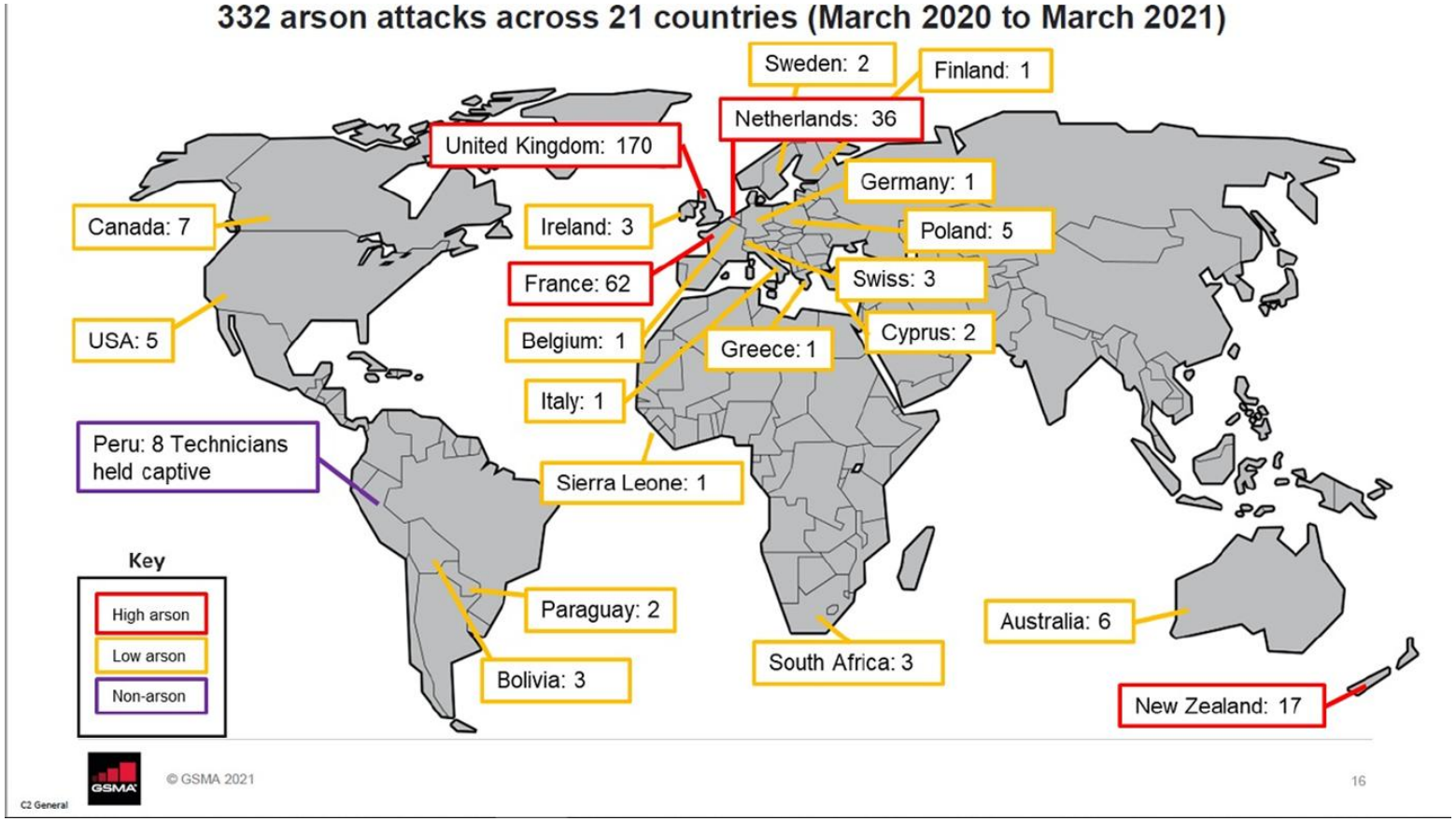


Dr. Fryderyk Lewicki
ITU Expert
Former Chairman of WP 1 EMF & EMC (2017-2024)
Former Rapporteur Q3/5 EMF (2005-2024)

Problems with 5G rollout – fake news

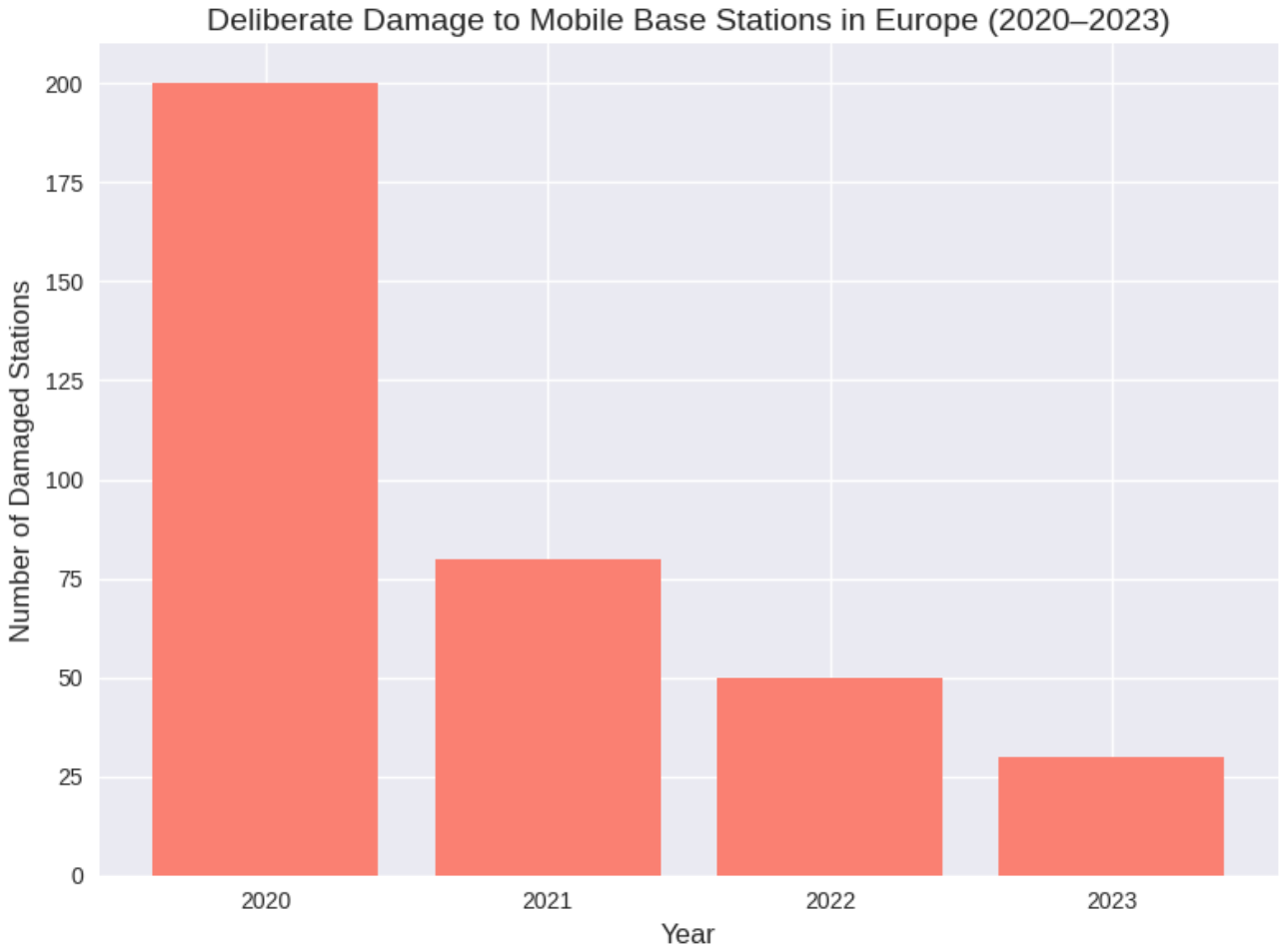






Source: The 10th GSMA EMF Forum 2021, Sarah Wylie, Vodafone

Intentionally Damaged Base Stations in Europe (2020–2023)

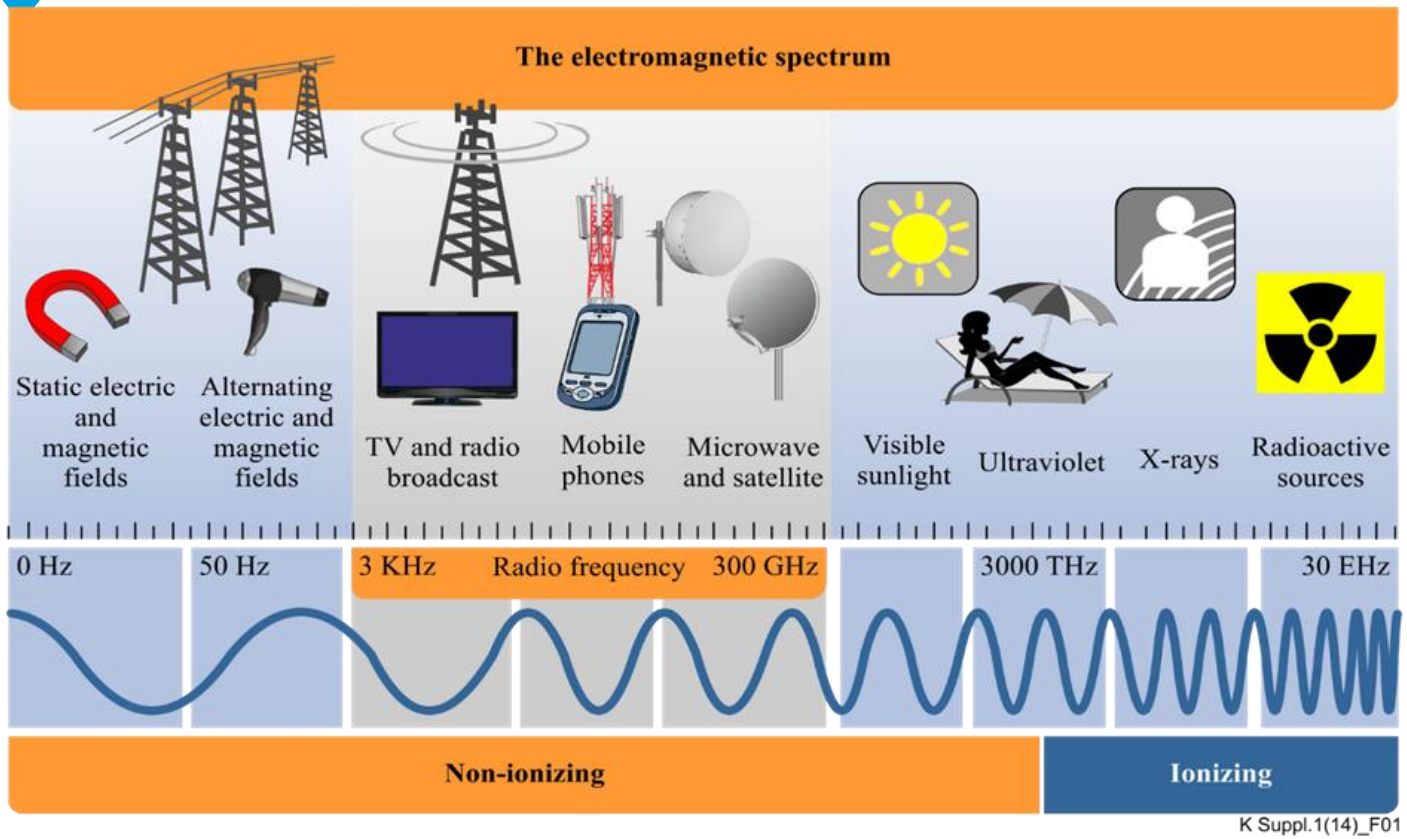


Year	Number of incidents
2020	200
2021	80
2022	50
2023	30

Over time, there has been a visible decline in the number of intentionally damaged mobile phone base stations in Europe

(Prepared using AI based on ENISA (European Union Agency for Cybersecurity), GSMA and country regulatory bodies data)

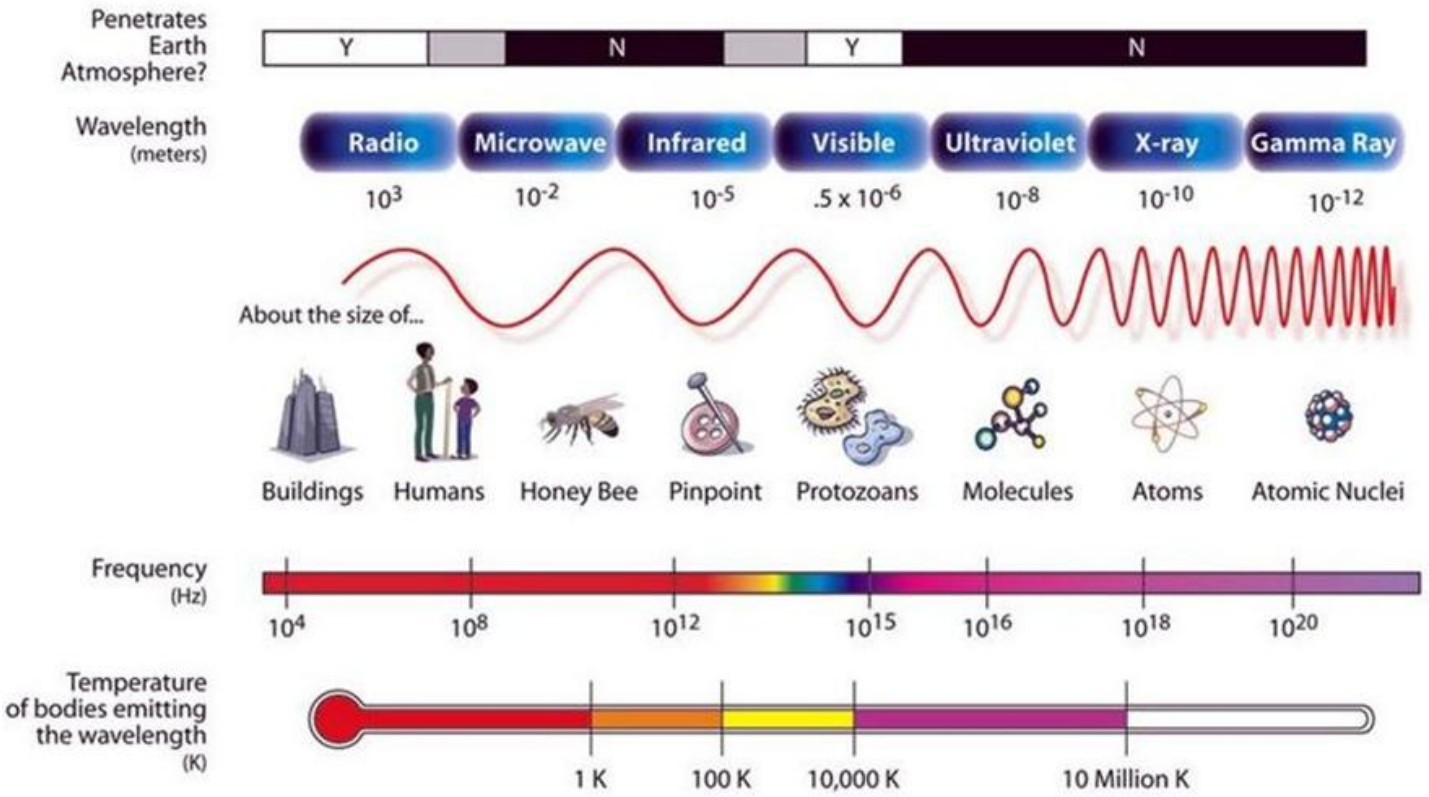
Introduction - Electromagnetic spectrum



Type of radiation	**Energy E = hν**
Microwaves and radiowaves (up to 10^{12} Hz)	**$10^{-3} \div 10^{-12}$ eV**
Infrared (temperature 20°C)	**$3 \cdot 10^{-2}$ eV**
Visible light	**1,6 ÷ 3,1 eV**
Ultraviolet light	**$3{,}3 \cdot 10^{2}$ eV**
X – rays	**10^{4} eV**
γ - rays	**10^{6} eV**
Energy of the nucleus bonds	**1 ÷ 15 eV**

- The frequencies used in mobile telephony are higher than those used in power supply systems and lower than the frequencies of visible light.
- RF EMF energy is too small to break chemical molecules bonds

Introduction - Electromagnetic spectrum



Frequency	Length 0,4 λ
50 Hz	2 400 km
225 kHz	533 m
1 MHz	120 m
70 MHz	1,7 m
200 MHz	0,6 m
630 MHz	0,19 m
900 MHz	0,13 m
1800 MHz	0,067 m

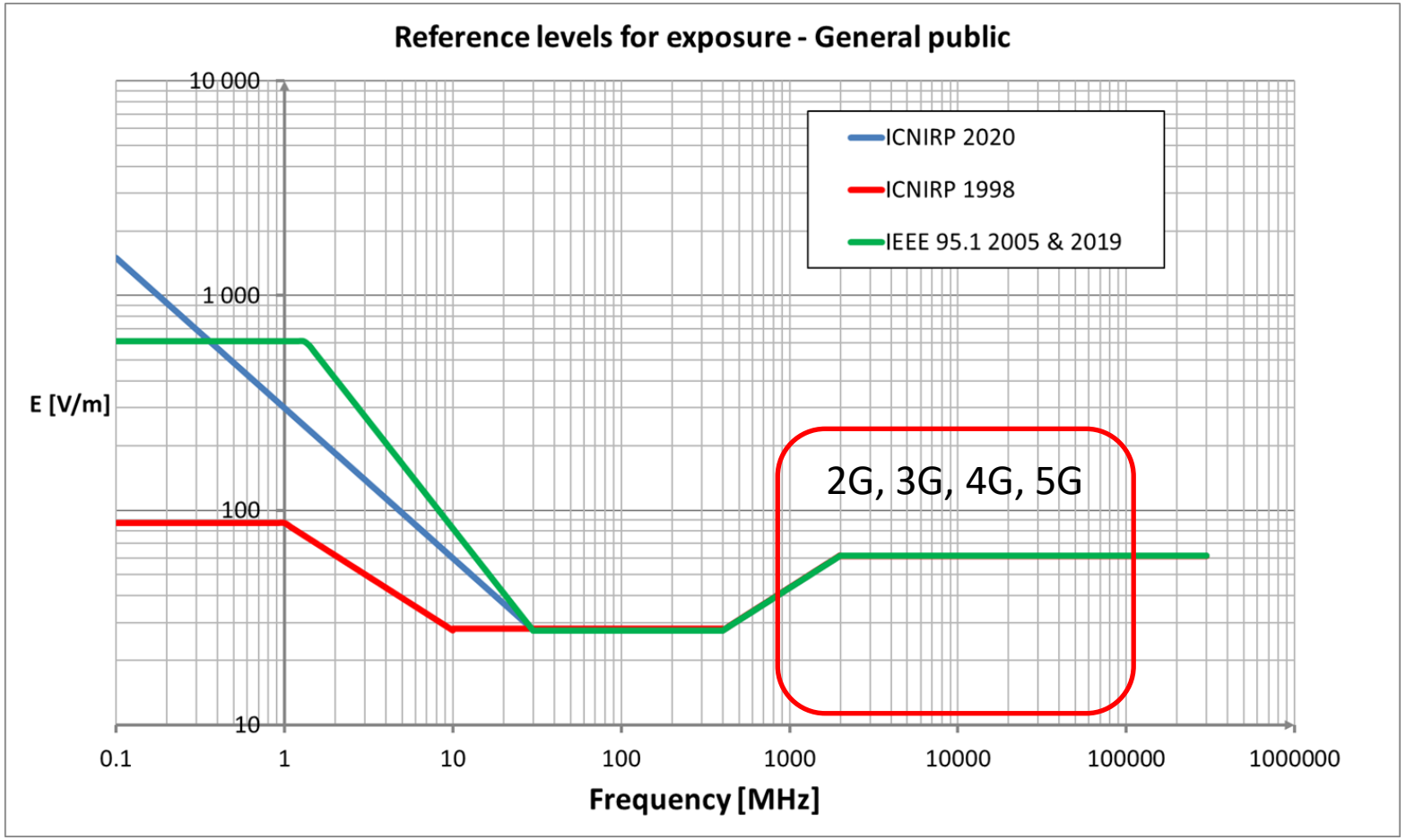
- Currently, 2G, 3G, 4G, and 5G systems primarily use frequencies below 4 GHz
- Resonance related to human size occurs at frequencies of the order of 100 MHz

Nonionizing radiation

- Non-ionizing radiation is detected by humans with the eyes (visible light) and the skin (infrared radiation – heating).
- Humans emit electromagnetic fields (EMFs, infrared) at a frequency of 300,000 GHz with a power density of 2.5 mW/m².
- The power density of solar radiation on a sunny, cloudless day is 800–1000 W/m² at ground level.

ZEISS Noctovizor NV 5,6 x 62 T

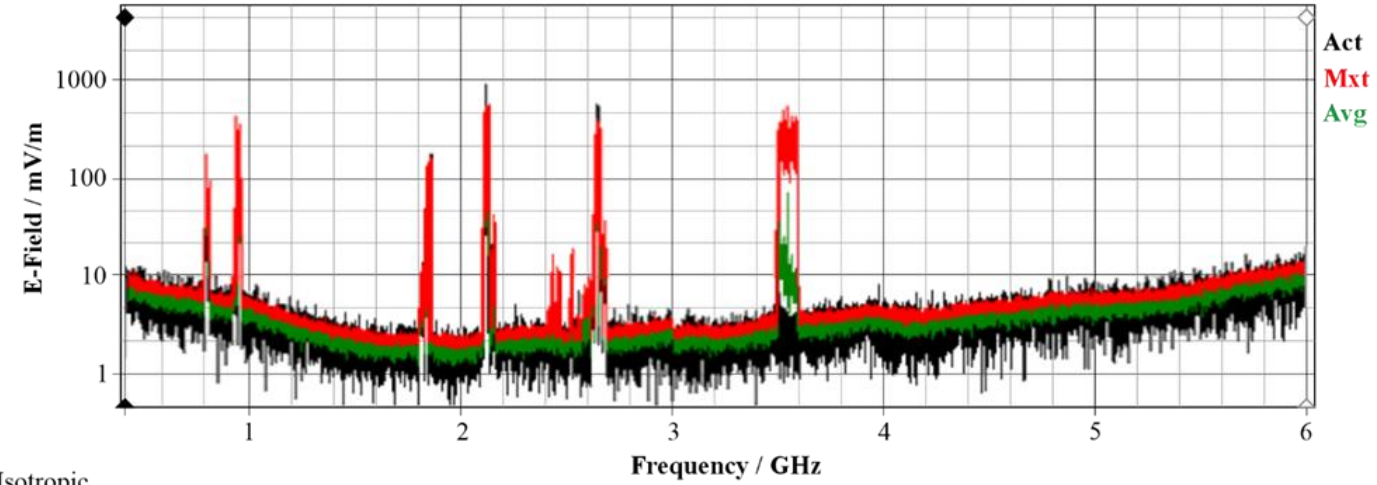
International exposure limits for general public



In approximately 20 years of intensive research, no basis has been found for changing exposure limits in the part of the spectrum used by mobile systems

Example of frequency selective measurement result

Battery:	Ext. power	GPS:	52°22'08.6" N	Ant:	3AX 0.4-6G	SrvTbl:	Tabela LBS
07.08.23	13:18:46		16°54'35.4" E	Cable:	—	Stnd:	ICNIRP GP
Integration over frequency		Min:	420.000 MHz	Max:	6 000.000 MHz	Result type:	Act
		Cent:	3 210.000 MHz	Span:	5 580.000 MHz	Int. val:	2.712 V/m



Isotropic

Index: 5.3 • TIME • Date: 07.08.23 13:18:46							
Fmin:	420 MHz	Fmax:	6 GHz	Sweep time:	1.319 s	**RECALL**	
MR:	5 V/m	RBW:	500 kHz			No. of runs:	45
		VBW:	Off			AVG:	4

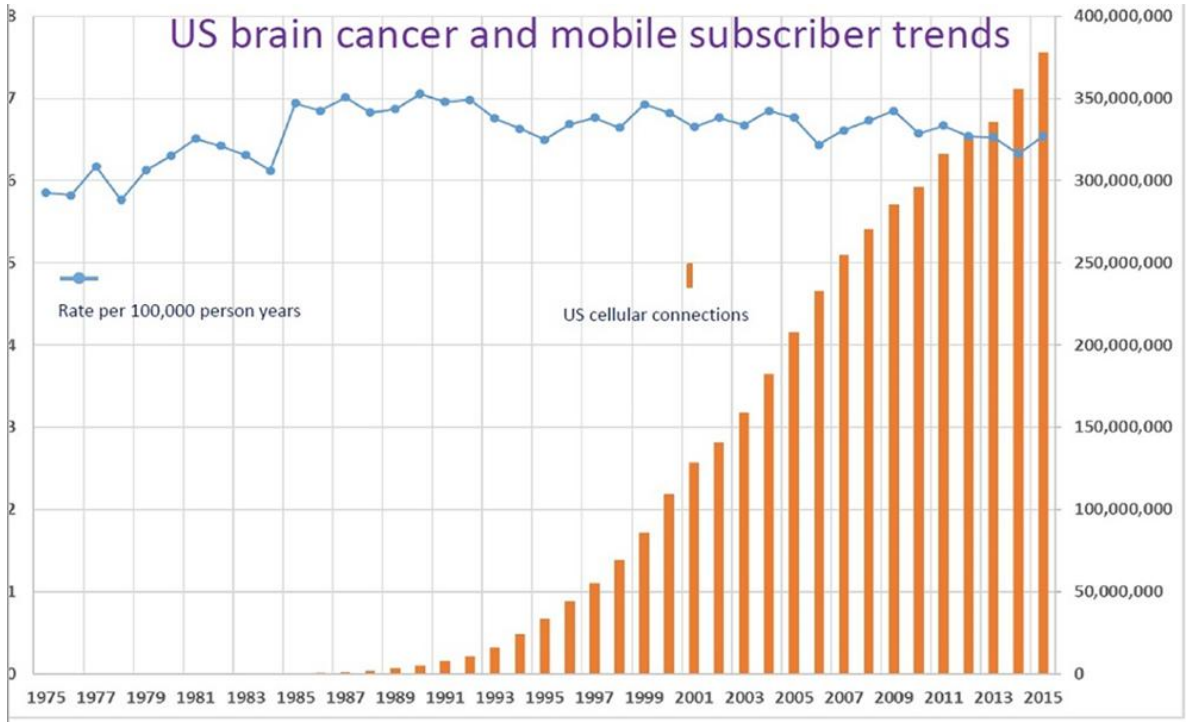
K.156(24)

In this typical case, the exposure level does not exceed 1 V/m in any of the cellular frequency bands

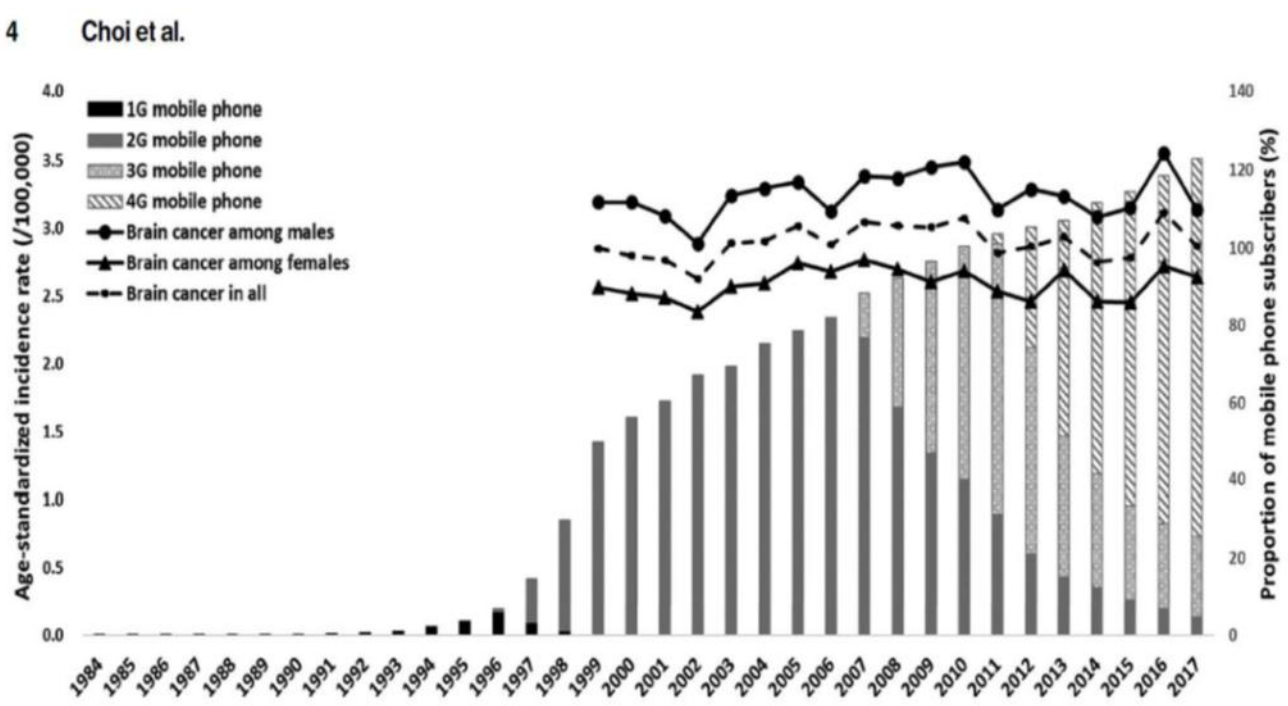
Basic restrictions – Specific Absorption Rate (SAR)

- The "basic limit" (SAR) is a measure used to assess the amount of energy absorbed by the human body.
- The WHO/ICNIRP considers a local SAR of 20 W/kg as the threshold for adverse health effects for the general population. Using a protection factor of 10, the exposure limit is SAR = **2 W/kg**.
- For comparison, an adult human generates (for the whole body) a total of approximately:
  - 1 W/kg at rest (Weyand et al., 2009)
  - **2 W/kg** while standing
  - 12 W/kg while running (Teunissen et al., 2007)
- The exposure limit for mobile devices is almost identical worldwide.

No correlation between mobile communication development & brain cancer - Examples from USA & South Korea

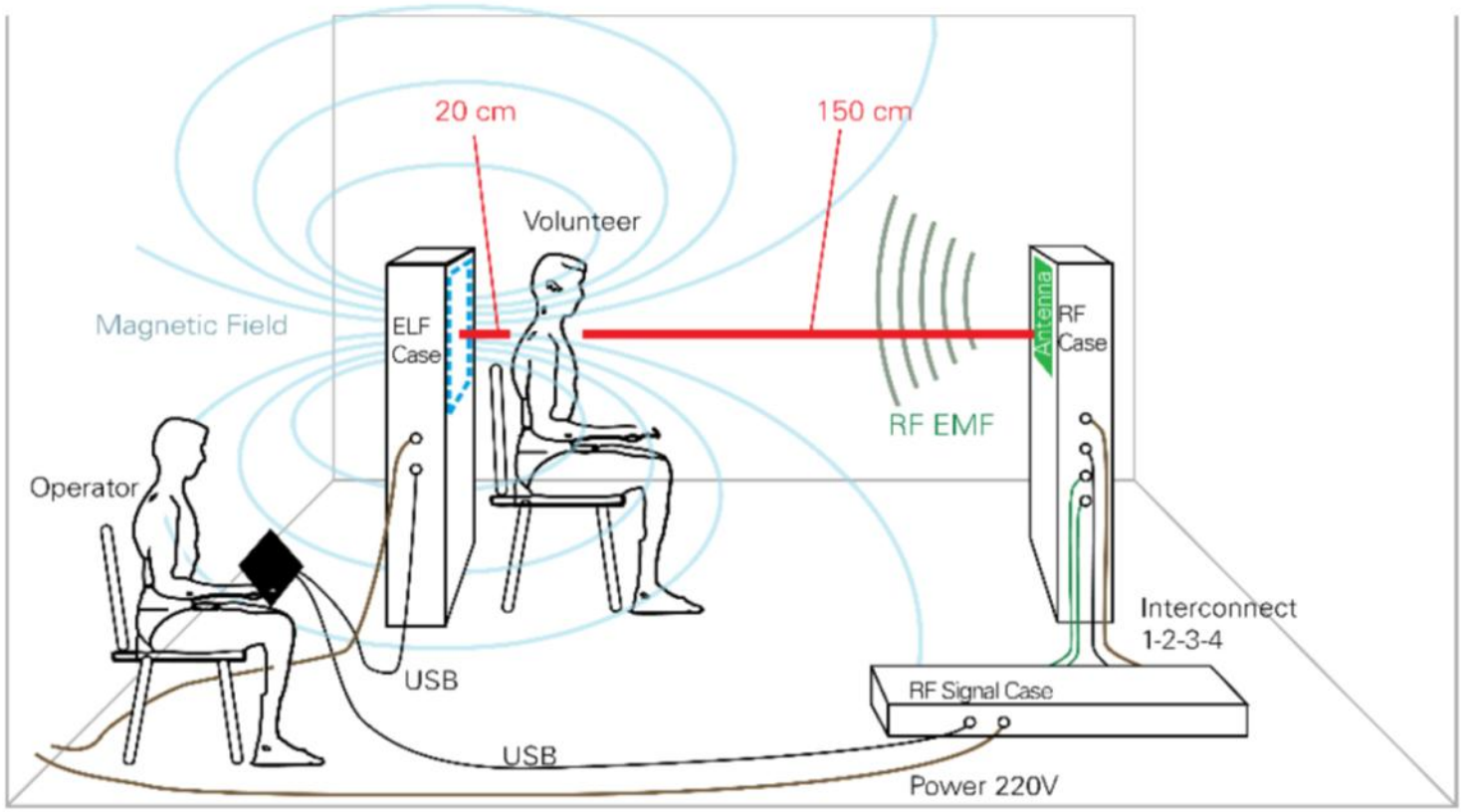


Source: Haim Mazar EMF and Health; CTIA and SEER data, and Inskip et al., 2010



https://doi.org/10.1002/bem.22373

Example of research results – EMF sensitivity



Van Moorselaaret al, Env Int, 2017, Anke Huss, University of Utrecht, NL

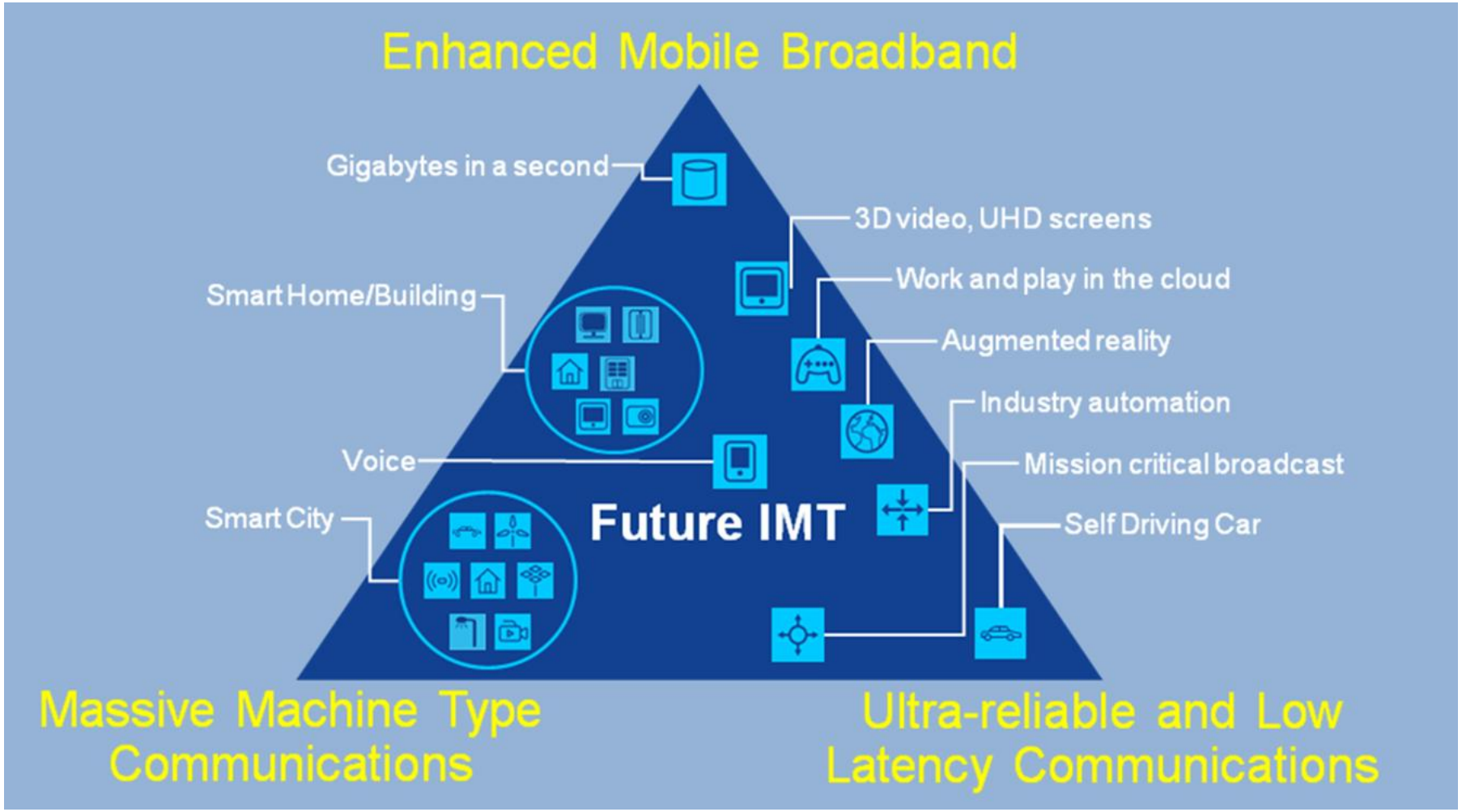
- Experimental study on 42 individuals reporting sensitivity to EMF
- Double-blind study, repeated 10 times
- Result: random agreement. Effects not during EMF exposure but during the belief in the EMF's effects

Introduction – natural and artificial EMF sources

- The RF EMF are present in our life as natural or man made sources
- Many of man made sources are present for many years: power lines (since the beginning of the XX century), radio (around 1900) and television (since 1927)
- Comparatively new is a mobile communication (with base stations) but it is present also for about 40 years (since 1980)

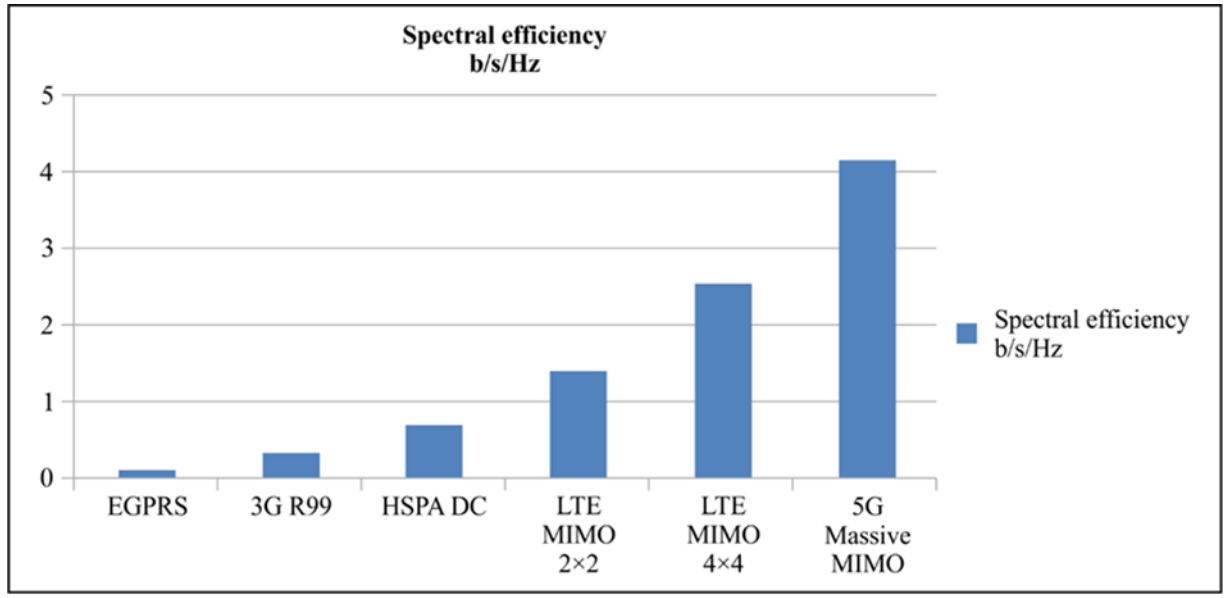
Source: Bailey et al., IEEE Access, 20 July 2020:

New features in 5G system

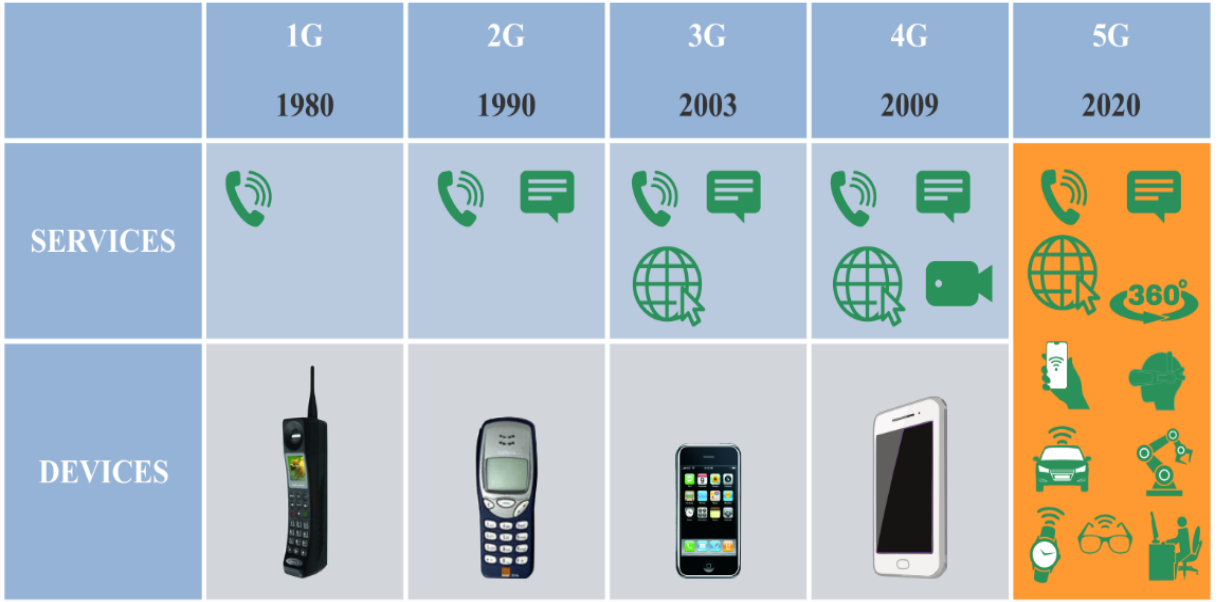


source: ITU-R M.2083 How Does 5G Work?

Development of the mobile systems



K Suppl.13(18)_F03

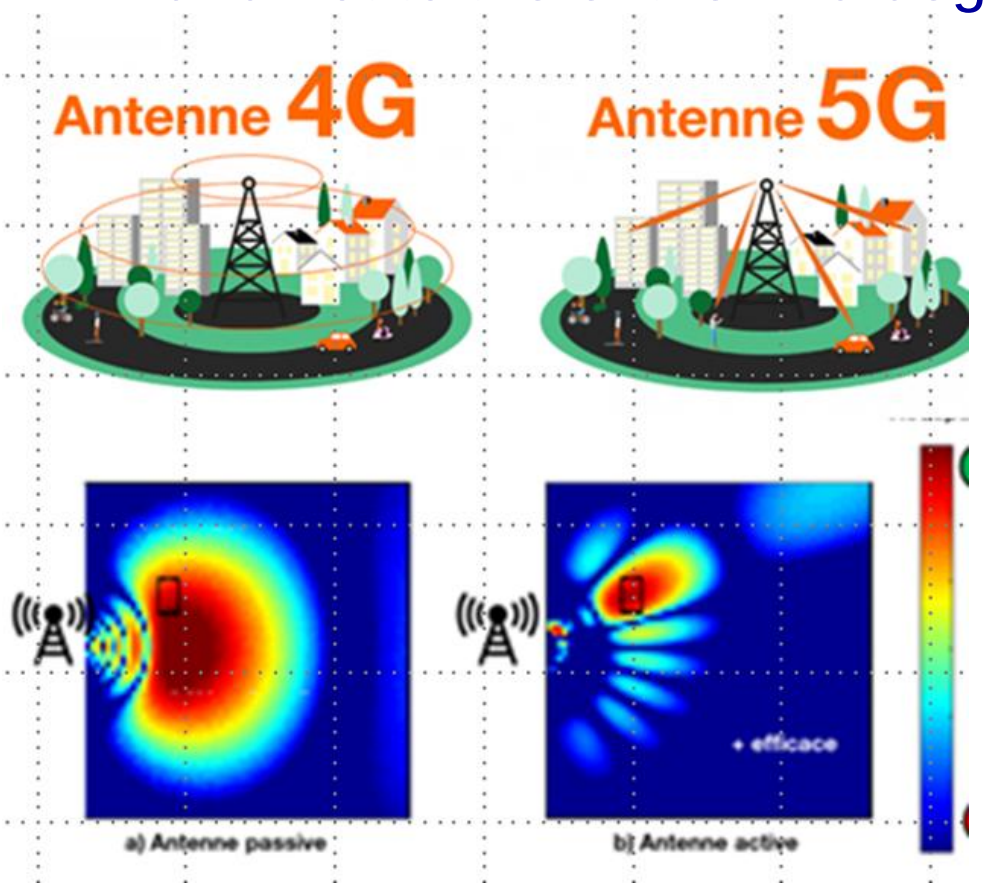


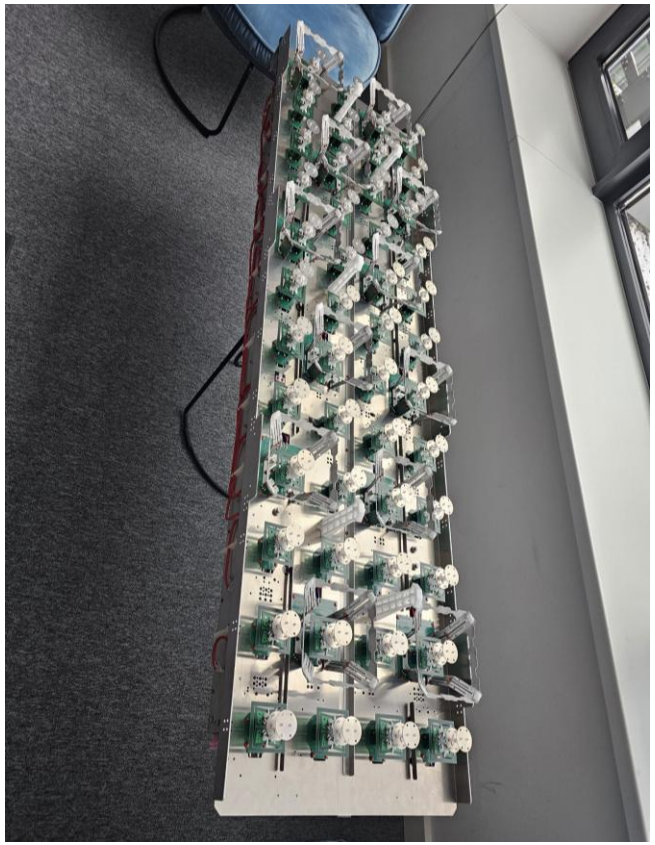
K Suppl.1(20)_F05

- Mobile systems (1G, 2G, 3G, 4G and 5G) are introduced to the market generally every 10 years. The 5G (in ITU IMT2020) was implemented in 2020
- There is now in 3GPP and ITU work on system 6G (IMT 2030) – planned for implementation in 2030.

Adaptive Antenna Systems (AAS antennas)

In the 5G system, adaptive antennas direct the signal towards the current user and not to the entire 120-degree sector as in 2G, 3G and 4G systems



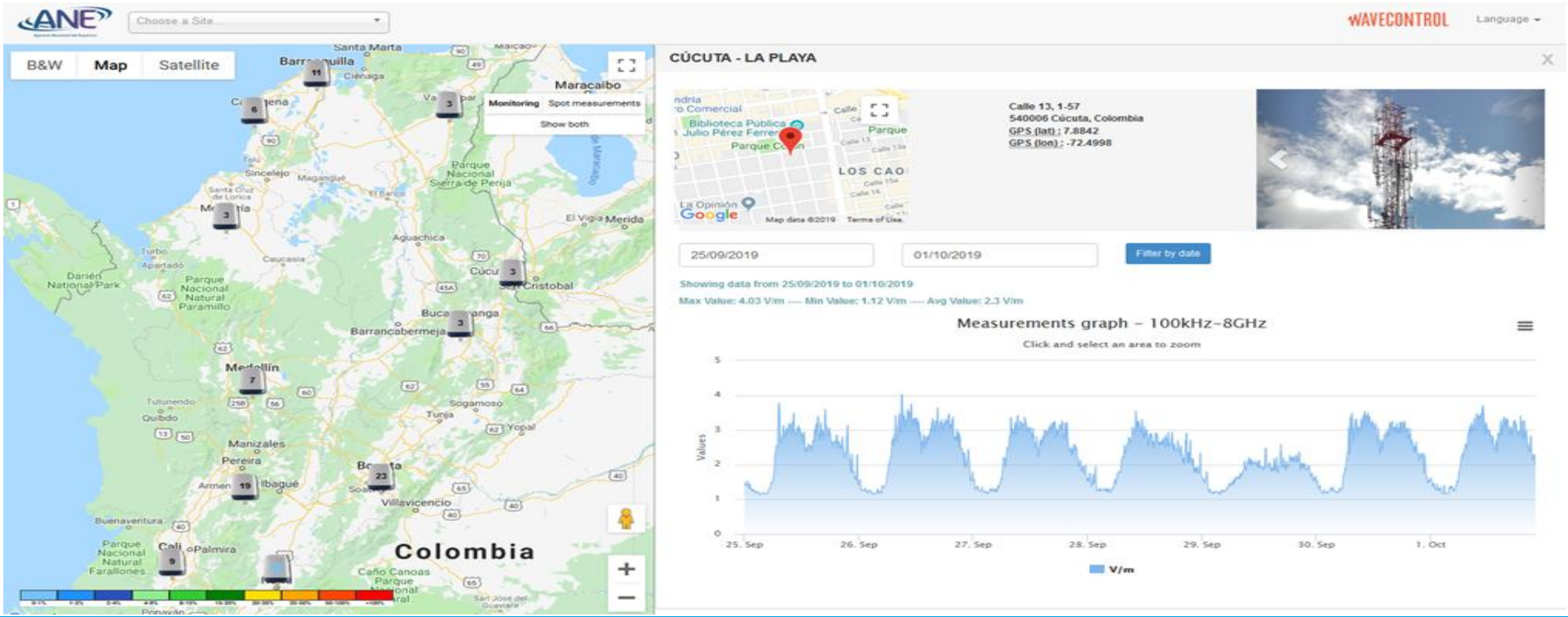


Higher cellular network frequencies are needed regardless of the launch of the 5G system, as they are required to meet growing user needs

- Higher frequency means a much smaller range but at the same time a much larger network capacity
- Low frequencies are used to obtain good coverage, high frequencies to ensure network capacity.

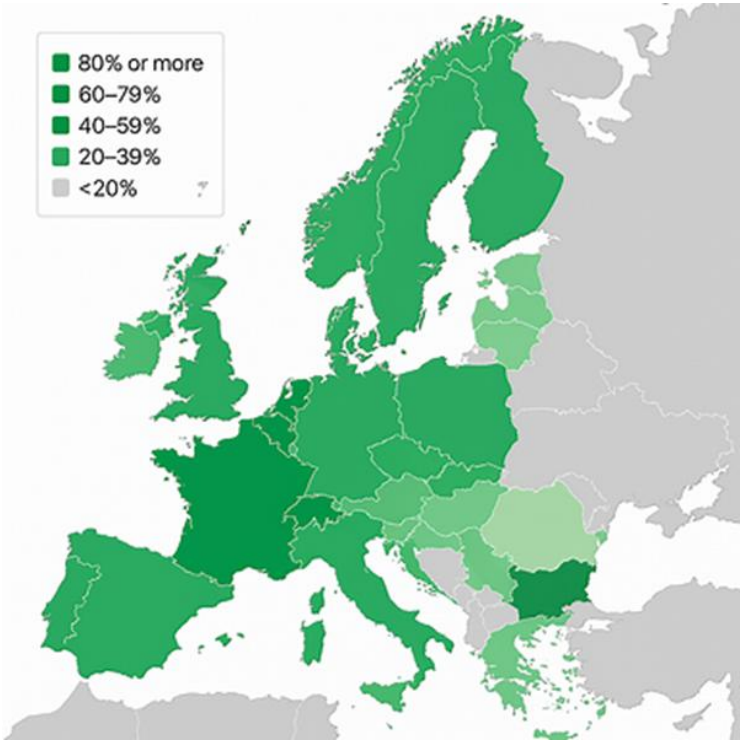
Monitoring of the RF EMF

- Continuous monitoring of radiofrequency EMF levels eliminates suspicions that operators are manipulating exposure levels.
- The maximum exposure level is constantly monitored and visible.
- Results can be shared with the public on a regular basis via a dedicated website.



5G coverage data for selected European countries, based on Q2 2025 statistics

Country	5G Coverage (Avg. Time in Range)	Notes
Switzerland	81.3%	Leading without subsidies – fast auctions and voluntary commitments
Sweden	~75%	Strong regulatory support and rural investment
Denmark	~72%	High availability via 700 MHz band and infrastructure sharing
Italy	~68%	Rapid growth thanks to subsidies and favorable regulations
Poland	~46%	Above EU average despite auction delays
EU Average	44.5%	Up from 32.8% the previous year
Belgium	11.9%	Among the lowest – regulatory hurdles
Hungary	~15%	Limited availability – low investment
Ukraine	<10%	Delay because of war
Albania Moldova	<5%	No commercial implementations



Source: Speedtest Intelligence & European 5G Observatory

Mobile devices and output power

Range of transmit power reduction for device under network power control and maximum output power for handheld devices (ITU-T K.Suppl.13)

Device network technology	Maximum output power (rms) of a handheld device (mW)	Minimum device transmit power relative to maximum level	Typical average transmit power relative to maximum level (%)
2G (GSM)	125-250	1/2000 – 1/4000 (−33 to −36 dB)	20-50
3G (wideband code division multiple access (WCDMA))	250	1/25000000 (−74 dB)	1-2
4G (long-term evolution (LTE))	200	1/2000000 (−63 dB)	1-2
5G (new radio (NR))	200	1/400000 (−56 dB)	1-2

Automatic Power Control ensures that the output power is the lowest possible to ensure good connection quality.

Summary

- Exposure levels - research results confirm previous findings
- A new mobile system is developed every 10 years. 6G is expected to be implemented in 2030.
- In most countries, licenses are technology-neutral – an operator can implement any mobile system of their choice on an assigned frequency.
- In the 5G system, adaptive antennas direct the signal towards the current user and not to the entire 120-degree sector as in 2G, 3G and 4G systems.
- Higher cellular network frequencies are needed regardless of the launch of the 5G system, as they are required to meet growing user needs.

Thank you!

Questions? Comments?

Email

flewicki@wp.pl