

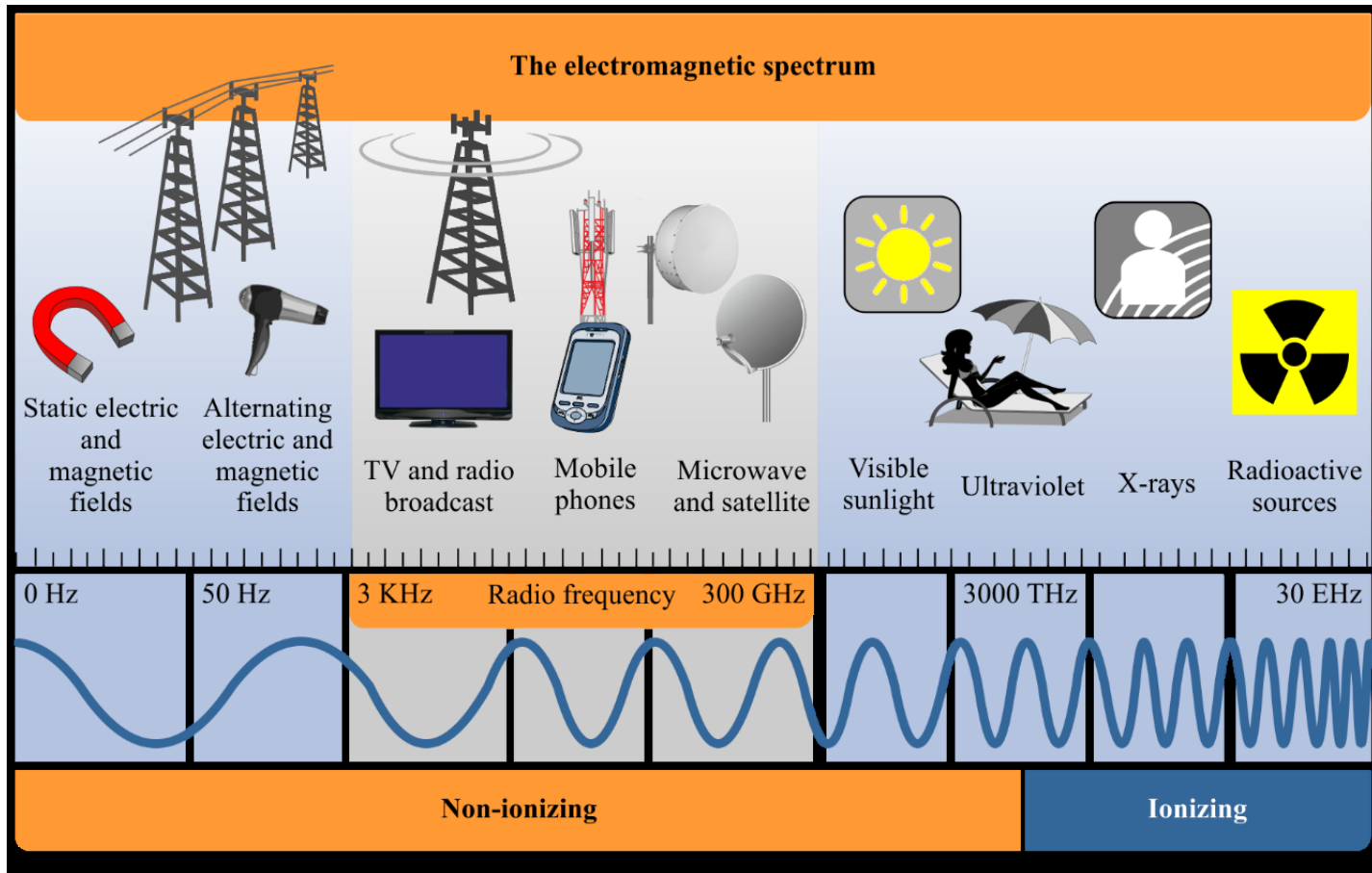
# ITU-T activities on Human Exposure to Electromagnetic Fields (EMFs)

8th Green Standards Week  
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# Introduction - Electromagnetic spectrum



Safety concerning RF EMF depends on frequency and exposure level

# The resonance phenomena of the exposure

Table 1. The quantum energy of the radiation

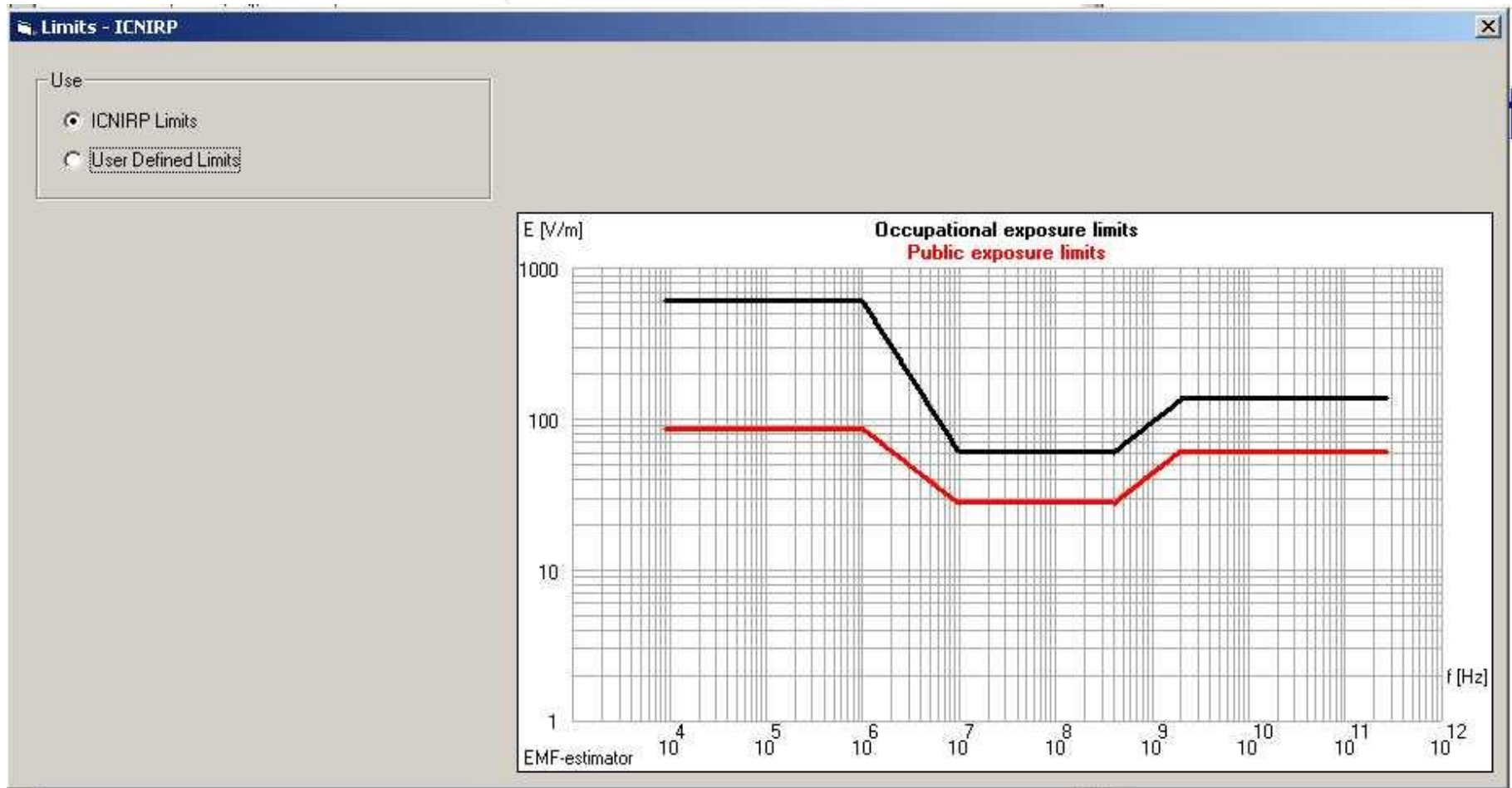
Type of radiation (frequency)	Energy $E = h\nu$
Radio Frequency (RF) radiation (up to $10^{12}$ Hz)	$10^{-3} \div 10^{-12}$ eV
Infra-red radiation (temperature $20^{\circ}\text{C}$ )	$3 \cdot 10^{-2}$ eV
Visible light	$1,6 \div 3,1$ eV
Ultraviolet light	$3,3 \cdot 10^2$ eV
Roentgen radiation	$10^4$ eV
$\gamma$ radiation	$10^6$ eV
Energy of chemical bonds of the molecules	$1 \div 15$ eV

# The resonance phenomena of the exposure

Frequency	Wavelength $0,4 \lambda$
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

- The maximum absorption of the human body (adult person) is for the radiation on the frequency: 35 MHz (grounded) to 70 MHz (ungrounded)
- For the lowest frequencies (for example 50 Hz or Long Waves) the human body is „transparent” for the electric field (very small absorption)

# WHO recommends the use of the ICNIRP exposure limits



ITU-T Recommendation K.70 Appendix I, EMF-estimator

# Exposure limits

- Data concerning exposure limits in different countries can be found on the WHO website:

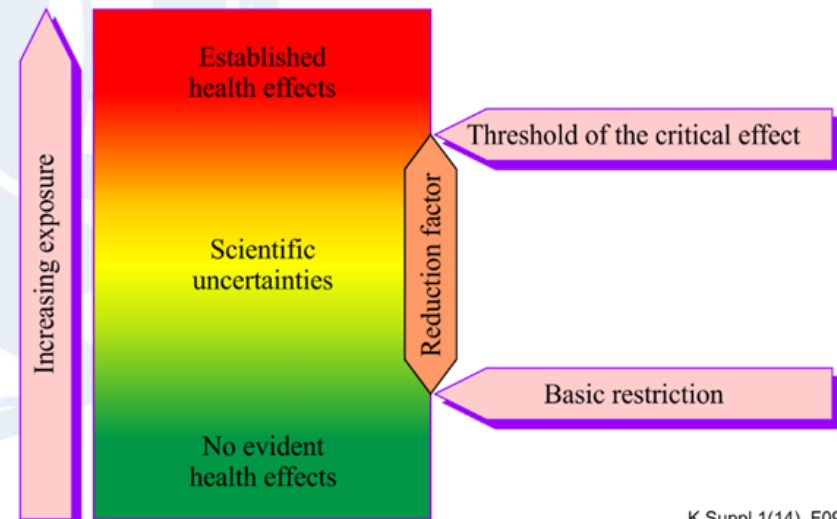
<http://apps.who.int/gho/data/node.main.EMFLIMITSPUBLICRADIOFREQUENCY?lang=e>

WHO recommends the use of the ICNIRP exposure limits

filter table | reset table  
Last updated: 2017-05-31

Download filtered data as: CSV table | XML (simple) | JSON (simple)  
Download complete data set as: CSV table | Excel | CSV list | more...

		Radiofrequency						
		Electric field (V/m) <sup>i</sup>		Power density (W/m <sup>2</sup> ) <sup>i</sup>		Specific absorption rate (SAR) (W/kg) <sup>i</sup>		
Country	Year	900 MHz	1800 MHz	900 MHz	1800 MHz	Whole body	Head and trunk	Limbs
Argentina	2017	41.25	58.36	4.5	9	0.08	2	4
Australia	2017	41.1 <sup>i</sup>	58.1 <sup>i</sup>	4.5 <sup>i</sup>	9 <sup>i</sup>	0.08	2	4
Austria	2017	41.25	58.34	4.5	9	0.08	2	4
Bahrain	2017	41	58	4.5	9	0.08	2	4
Belgium	2017	<sup>i</sup>	<sup>i</sup>	<sup>i</sup>	<sup>i</sup>			
Brazil	2017	41.25	58.34	4.5	9	0.08	2	4
Bulgaria	2017	6.14 <sup>i</sup>	6.14	0.1 <sup>i</sup>	0.1			
Canada	2017	32.1 <sup>i</sup>	40.07 <sup>i</sup>	2.74 <sup>i</sup>	4.4 <sup>i</sup>	0.08	1.6 <sup>i</sup>	4
Chile	2017			0.1/1.0 <sup>i</sup>	0.1/1.0 <sup>i</sup>	1.6/2 <sup>i</sup>	1.6/2 <sup>i</sup>	1.6/2 <sup>i</sup>
Cuba	2017						0.8/1.6 <sup>i</sup>	
Cyprus	2017	41	58	4.5	9	[0.08]	[2]	[4]
Finland	2017	41.4	58.55	4.5	9	0.08	2	4
France	2017	41	58	4.5	9	0.08	2	4



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# Review of the exposure limits

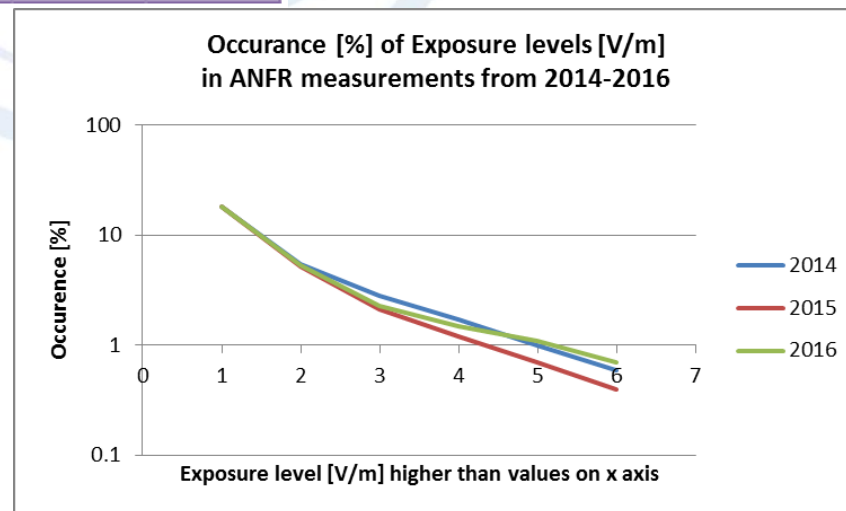
- The exposure limits for RF EMF – in the ICNIRP guidelines and in countries with much more restrictive limits

Frequency band	ICNIRP limit (UE etc.)	IEEE limit C.95.1-2005	Example of more restrictive limits
<b>Basic restrictions</b>			
10MHz<f<3GHz	0.08 W/kg	0,08 W/kg	-
3GHz<f<10GHz	0,08 W/kg	10 W/m <sup>2</sup>	-
10GHz<f<300GHz	10 W/m <sup>2</sup>	10 W/m <sup>2</sup>	-
<b>Reference levels</b>			
400MHz<f<2GHz	2W/m <sup>2</sup> -10W/m <sup>2</sup> (28 V/m-61V/m)	2W/m <sup>2</sup> -10W/m <sup>2</sup> (27.5 V/m-61V/m)	0,1 W/m <sup>2</sup> (7V/m)
f>2GHz	10 W/m <sup>2</sup> (61 V/m)	10 W/m <sup>2</sup> (61 V/m)	0,1 W/m <sup>2</sup> (7V/m)

# Current exposure levels

- In the table below there are results of the measurements of the electric field strength in about 3000 measurement points made by the French Agency ANFR in 2014-2016 (Etude de l'exposition du public aux ondes radioélectriques, ANFR, October 2017)
- In more than 80% of the locations the exposure level was lower than 1 V/m
- In less than 1% of the locations the exposure level was higher than 6 V/m

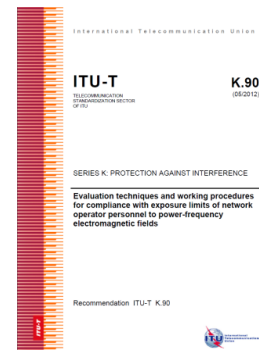
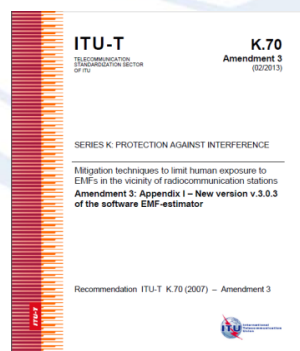
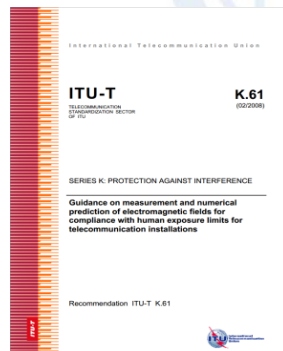
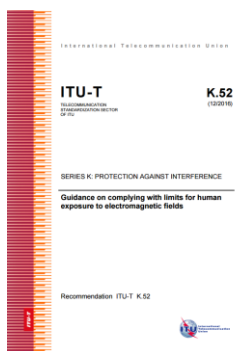
Année	E (V/m)	≥ 1 V/m	≥ 2 V/m	≥ 3 V/m	≥ 4 V/m	≥ 5 V/m	≥ 6 V/m
2014	Occurrence (%)	18,3 %	5,5 %	2,8 %	1,7 %	1 %	0,6 %
2015	Occurrence (%)	18,4 %	5,2 %	2,1 %	1,2 %	0,7 %	0,4 %
2016	Occurrence (%)	18,4 %	5,3 %	2,3 %	1,5 %	1,1 %	0,7 %





# ITU-T Recommendations on EMF

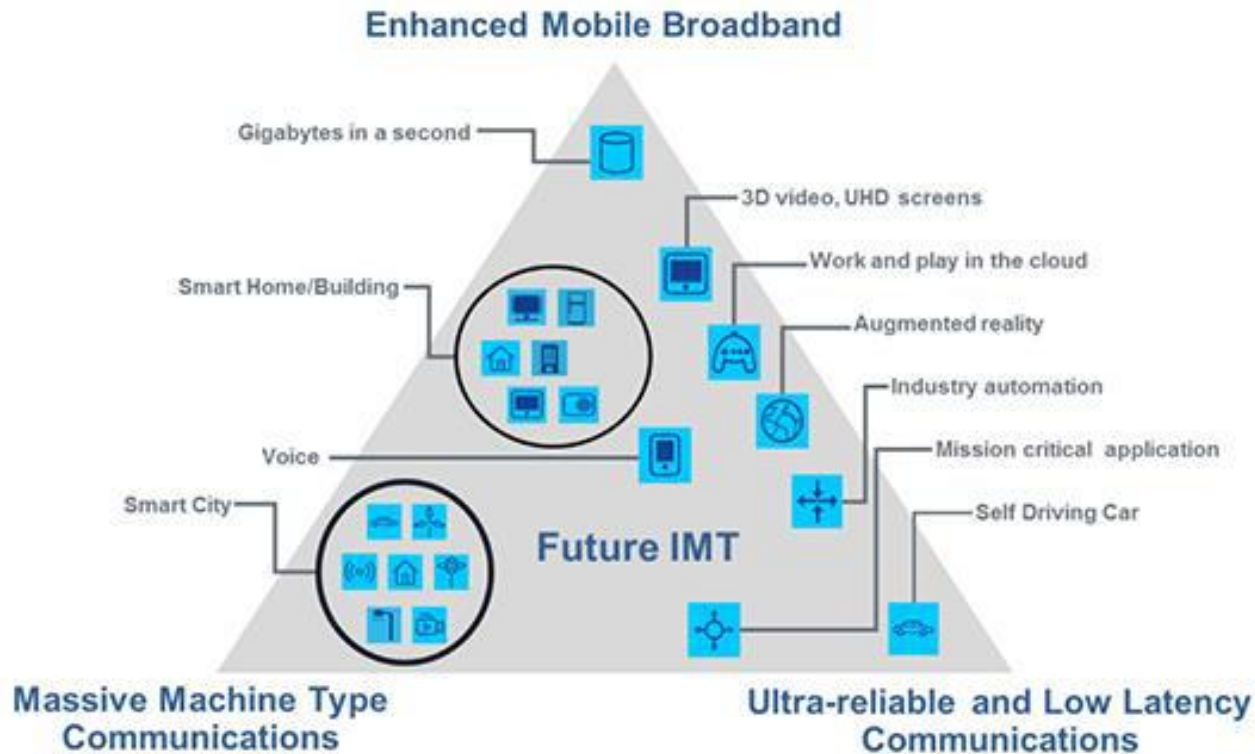
- **Recommendation ITU-T K.52 (2000/2017)** - Guidance on complying with limits for human exposure to electromagnetic fields – **includes „K.52calculator” software**
- **Recommendation ITU-T K.61 (2003/2017)** - Guidance on measurement and numerical prediction of electromagnetic fields for compliance with human exposure limits for telecommunication installations
- **Recommendation ITU-T K.70 (2007/2017)** - Mitigation techniques to limit human exposure to EMFs in the vicinity of radiocommunication stations – **includes „EMF Estimator” software**
- **Recommendation ITU-T K.83 (2011/2014)** - Monitoring of electromagnetic field levels
- **Recommendation ITU-T K.90 (2012/2017)** - Evaluation techniques and working procedures for compliance with exposure limits of network operator personnel to power-frequency electromagnetic fields– **includes „EMFACDC” software**



# Introduction - 5G mobile systems

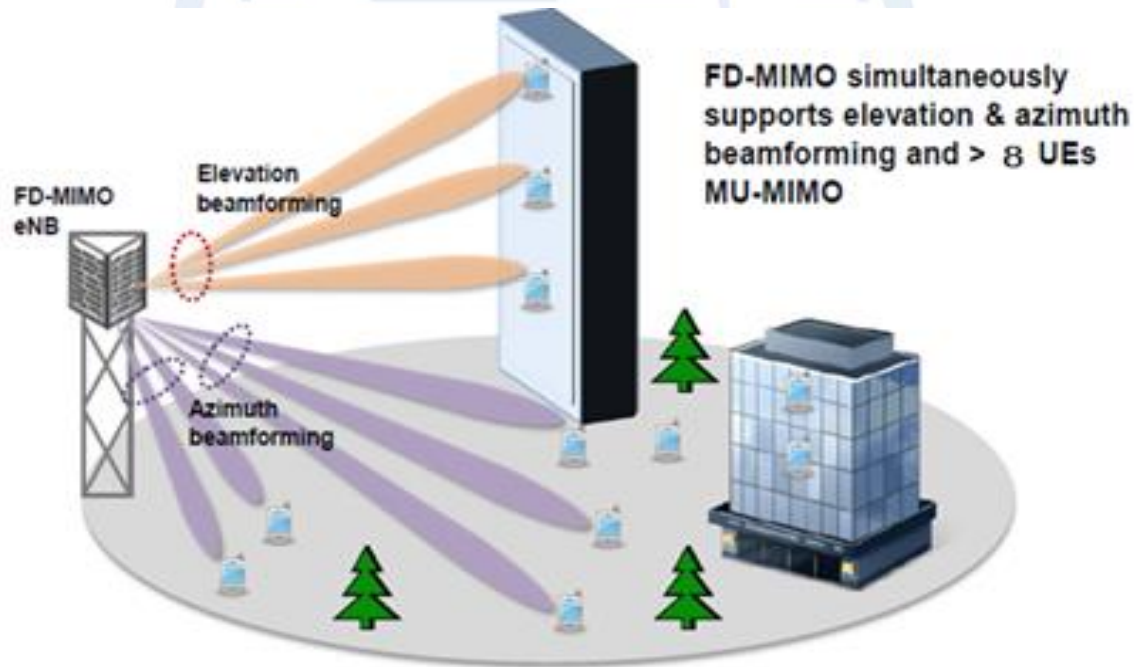
The 5G system will cover three main different applications with different properties

- Enhanced Mobile Broadband
- Massive Machine Type Communications
- Ultra-reliable and Low Latency Communications



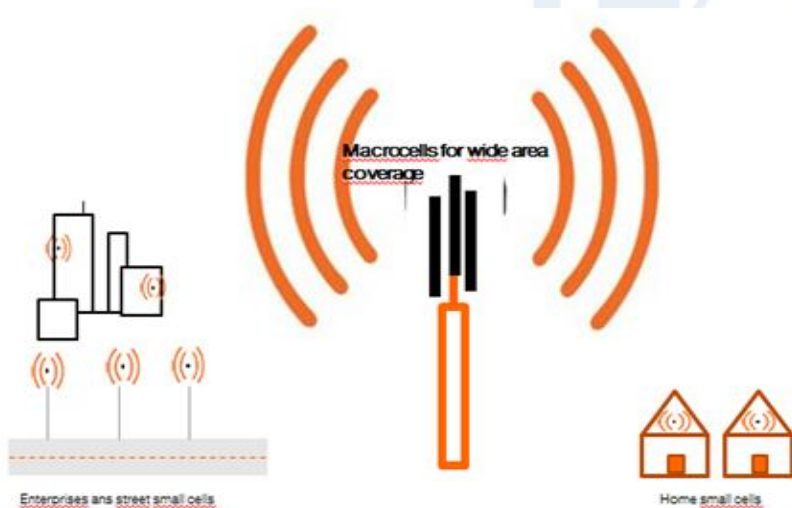
# Smart antennas

- Current mobile systems: 2G, 3G and 4G apply base stations that are covering the whole intended area
- Smart antennas, that are planned for use in 5G will have narrow antenna beam (or beams) directed directly to the user (or users)
- This will allow to substantially reduce the exposure in the environment

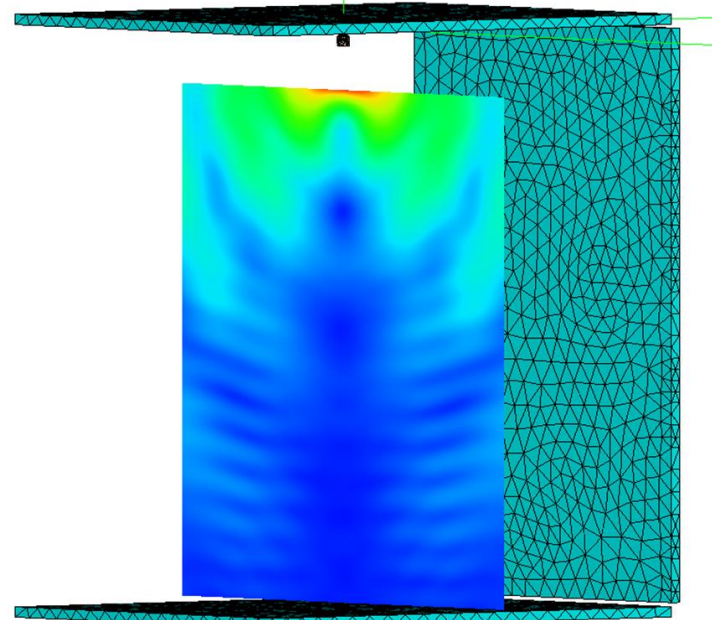


# 5G and small cells

- Small cells will be much widely used especially for the high speed transmission that requires a very broadband transmission
- The use of the higher frequencies will result in lower coverages – small cells. Base stations will be located closer to the user, but the used power will be smaller too
- Current experience shows that the use of the small cells (indoor and outdoor) reduces overall exposure level

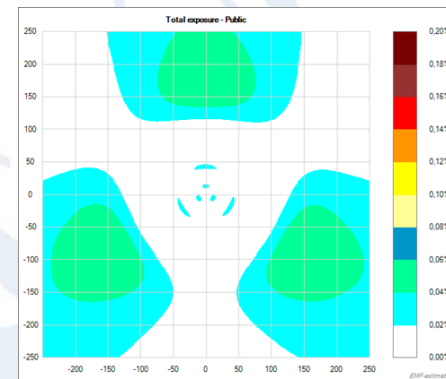
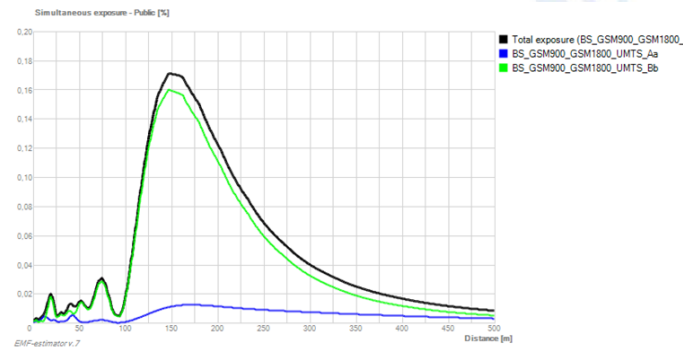
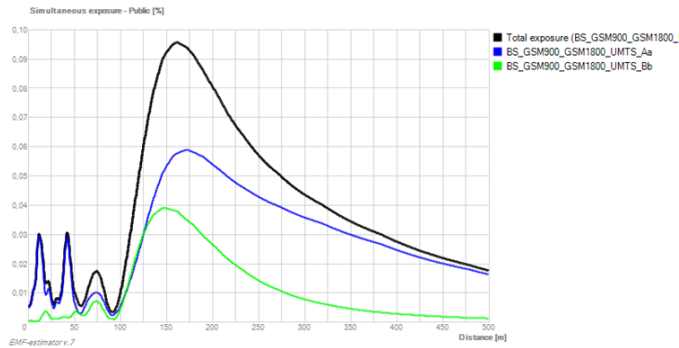


Electric field [V/m]

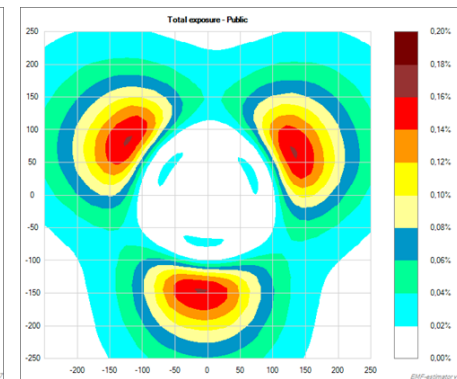


# Sharing infrastructure

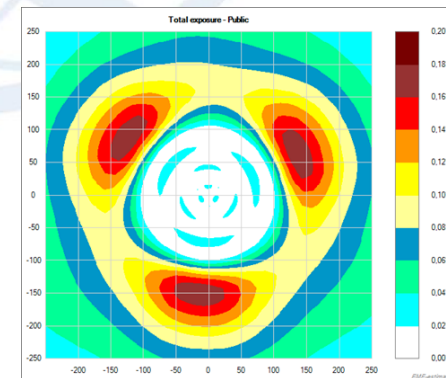
- It is predicted that operators applying 5G mobile systems will share physical infrastructure more frequently (shared sites)
- Below an example of exposure level around two co-located base stations is presented (colored lines) together with total exposure level (black line)
- The total exposure is lower than simple sum of that caused by each operator



Base Station A



Base Station B



Base Stations A+B

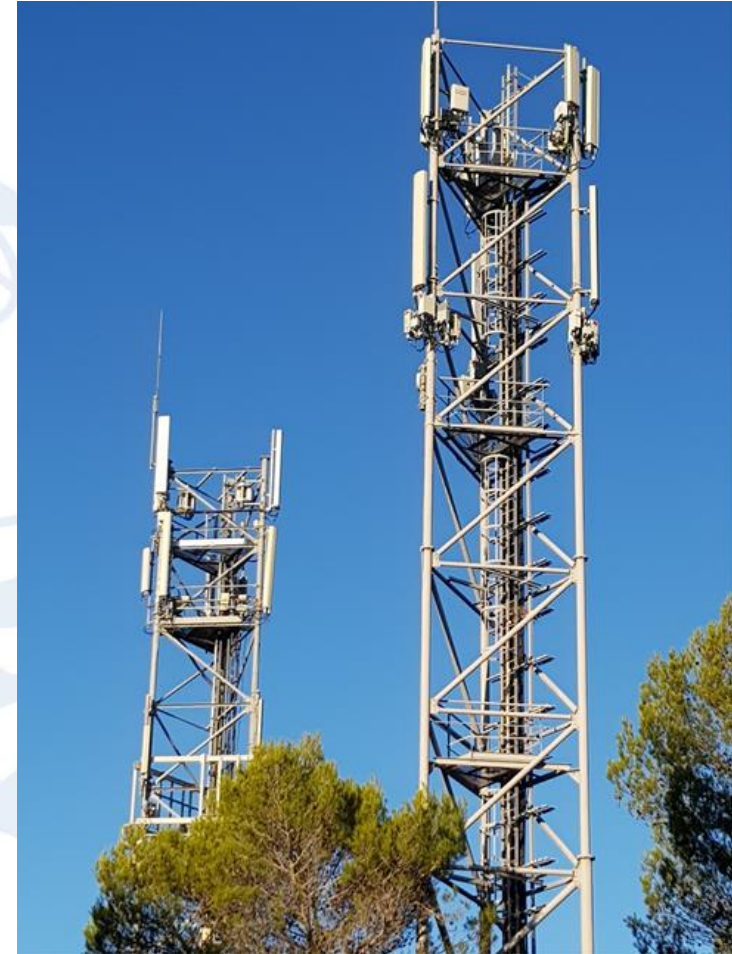
# Internet of things (IoT), M2M

- It is expected that many devices will be connected to the internet using radiowaves. It will result in many possible improvements in our lives
- It means that the number of radiating sources will increase dramatically
- Almost all of them will be very low power and short range devices. They will communicate on the event-based, periodic and automatic communication modes
- It means that the exposure level from such devices will be very low



# Conclusions

- ITU-T SG5 is very active in sharing knowledge and tools concerning assessment of human exposure to RF EMF
- Good communication with public is a very important task
- Efficient deployment of wireless infrastructure reduces the RF EMF exposure from networks and devices
- In the development of the 5G system the possibility of the reduction of the human exposure to RF EMF is one of the key issues to be taken into account



# Thank you Questions ?

