

# Impact of 5G technology on human exposure

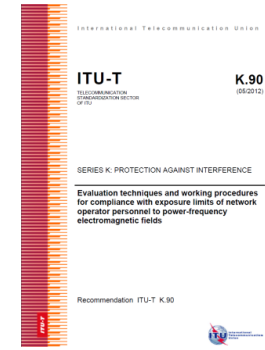
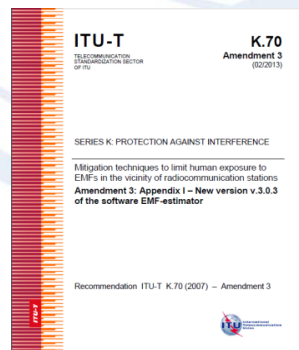
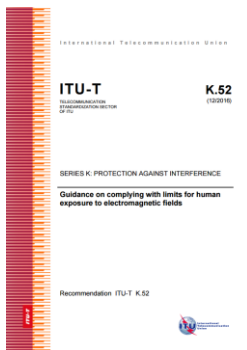
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# ITU-T Recommendations on EMF

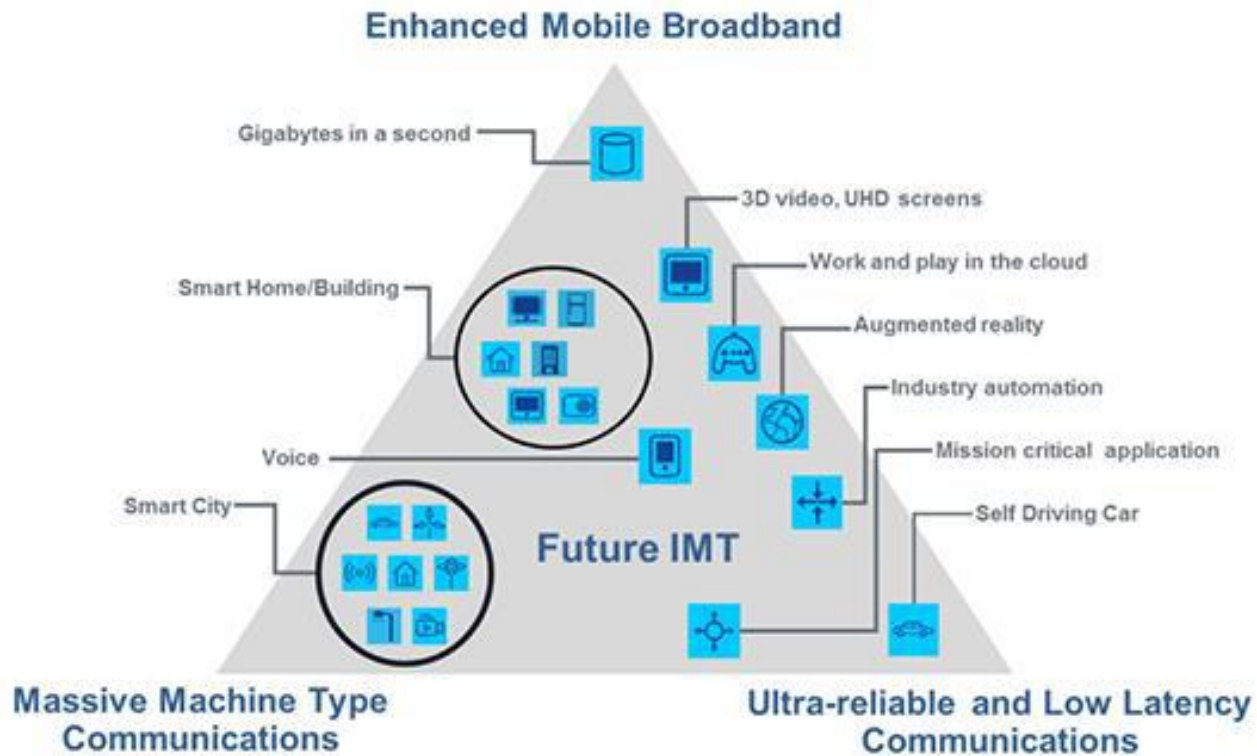
- **Recommendation ITU-T K.52 (2000/2017)** - Guidance on complying with limits for human exposure to electromagnetic fields – **includes „K.52calculator” software**
- **Recommendation ITU-T K.61 (2003/2017)** - Guidance on measurement and numerical prediction of electromagnetic fields for compliance 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

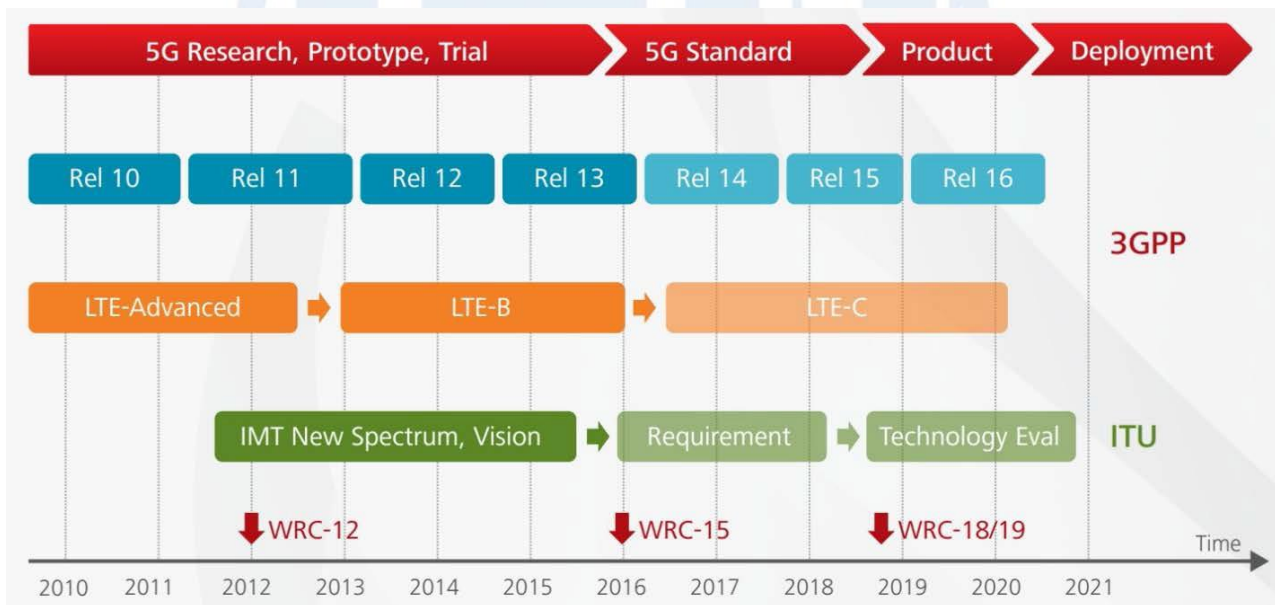
From human exposure to EMF point of view the important is that 5G system will cover three main different applications with different properties

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



# 5G Time Table

- 5G New Radio (NR) standard is still under development – expected to be finished in 2020
- All current implementations represent some form of the implementation of chosen features of 5G NR system only
- 5G NR system will use frequencies currently used by mobile communication but also new, especially microwave frequencies



Source: Commerce Spectrum Management Advisory Committee (CSMAC), 5G Subcommittee, Final Report, August 1, 2016

# Review of the exposure limits

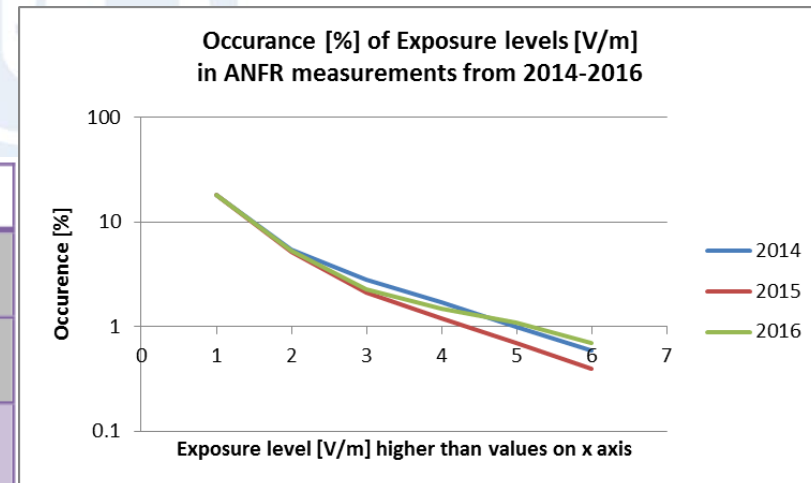
- The exposure limits in most countries are that recommended by WHO and based on ICNIRP or IEEE guidelines
- In some countries exposure limits are much more restrictive
- Because of increasing number of radiating sources and operating frequencies it may be expected that the compliance with exposure limits will be more difficult to achieve

Frequency band	ICNIRP limit (UE etc.)	IEEE limit C.95.1-2005	Example of more restrictive limits
Basic restrictions			
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>	-
Reference levels			
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 Table below there is presented results of measurements of the electric field strength in about 3000 measurement points made by Franch Agency ANFR in 2014-2016 (Etude de l'exposition du public aux ondes radioélectriques, ANFR, October 2017 )
- In more than 80% of locations the exposure level is lower than 1 V/m
- In less than 1% of locations the exposure level is higher than 6 V/m

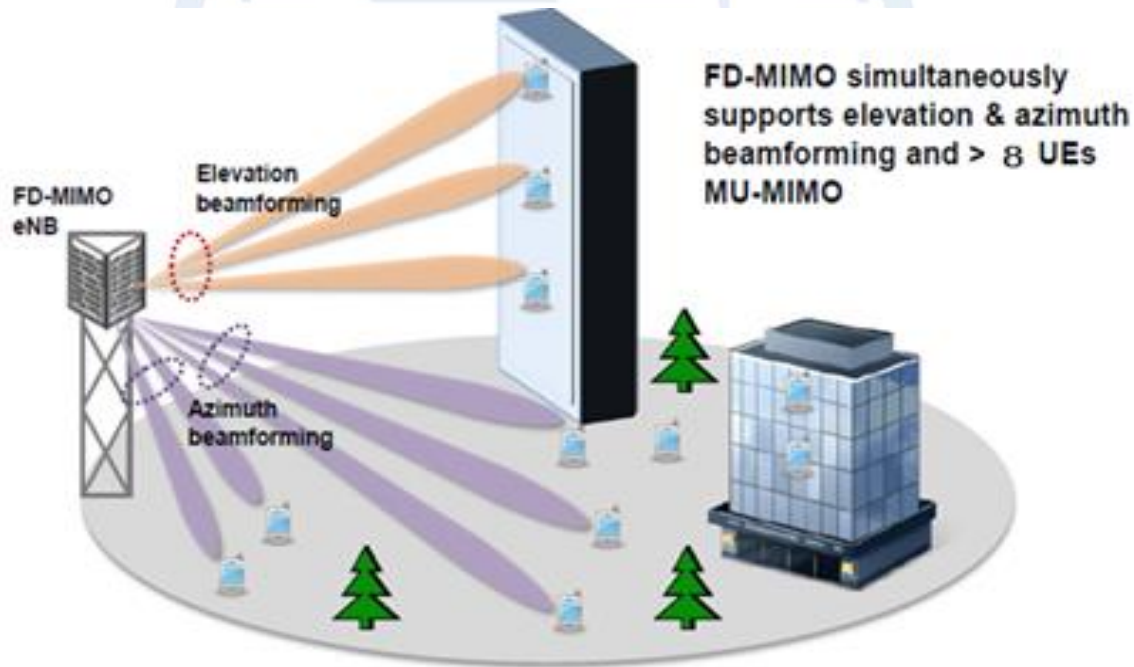
Année	E (V/m)	≥ 1 V/m	≥ 2 V/m	≥ 3 V/m	≥ 4 V/m	≥ 5 V/m	≥ 6 V/m
2014	Occurrence (%)	18,3 %	5,5 %	2,8 %	1,7 %	1 %	0,6 %
2015	Occurrence (%)	18,4 %	5,2 %	2,1 %	1,2 %	0,7 %	0,4 %
2016	Occurrence (%)	18,4 %	5,3 %	2,3 %	1,5 %	1,1 %	0,7 %





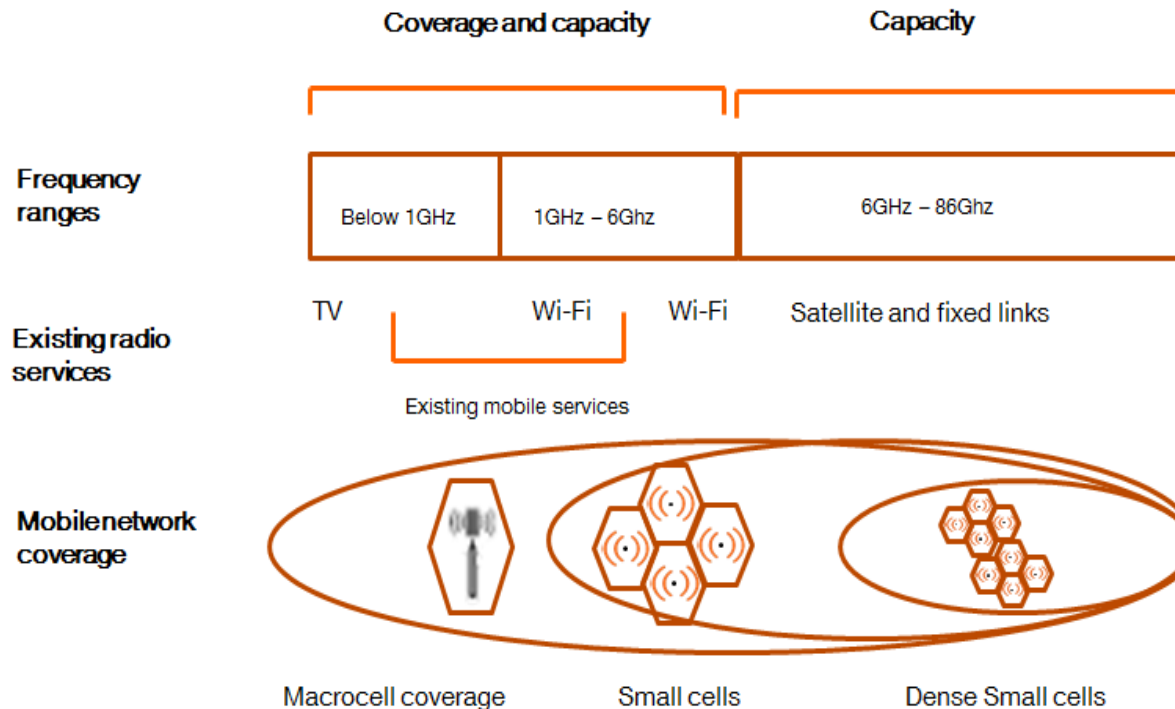
# Smart antennas

- 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 exposure in the environment



# 5G networks

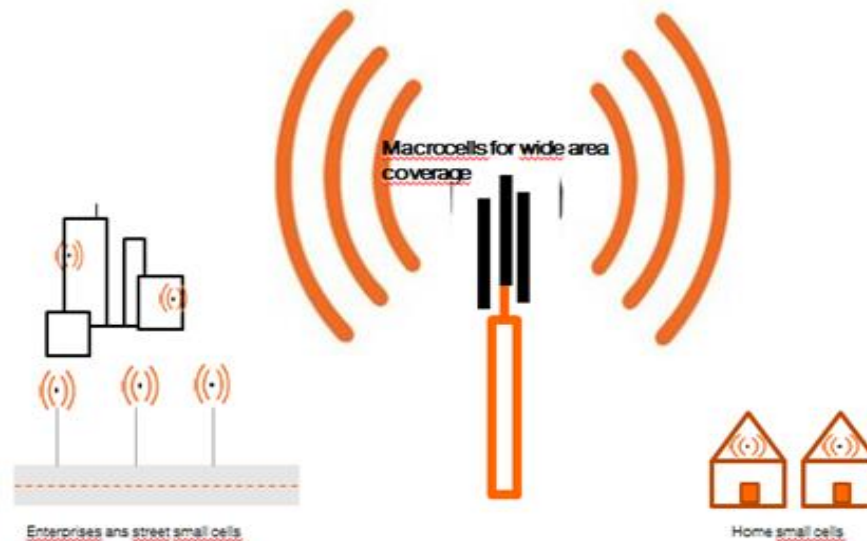
- 5G NR radio access network will combine all types of cells: macro (big coverage), micro, small and piko/femto (small coverage)
- 5G systems will operate in parallel with older one, so there will be increase of the exposure level at least during 5G implementation phase
- Advanced sleep mode will allow for substantial reduction of the exposure in case of low traffic





# 5G and small cells

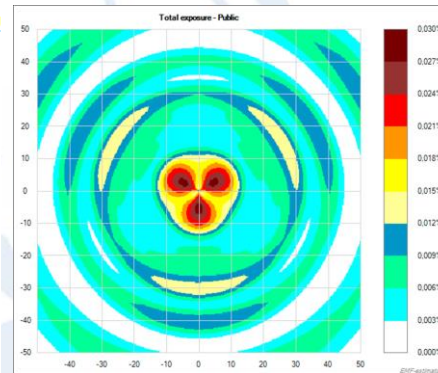
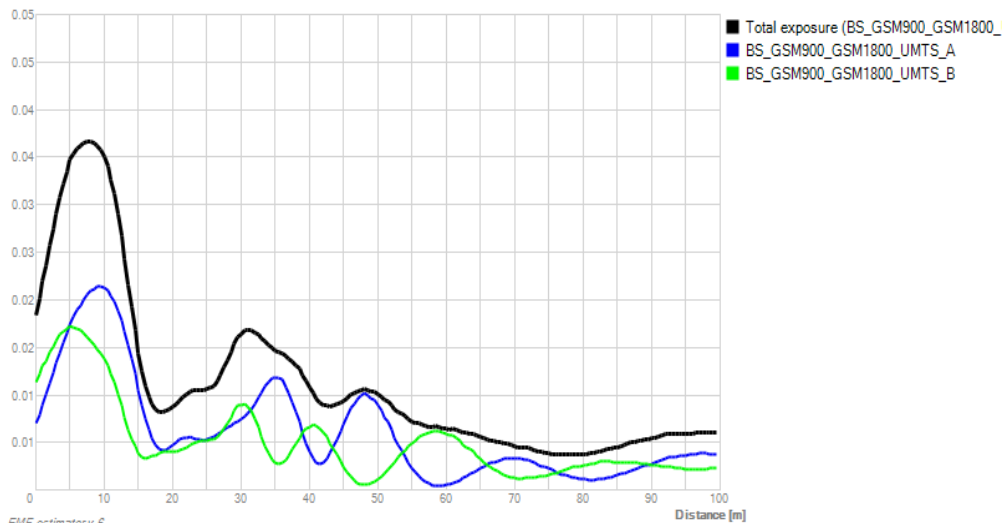
- Small cells will be much widely used especially for the high speed transmission that require very broadband transmission
- The use of the higher frequencies will result with lower coverages – small cells. Base stations will be located closer to the user, but the power used will be smaller too
- Current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



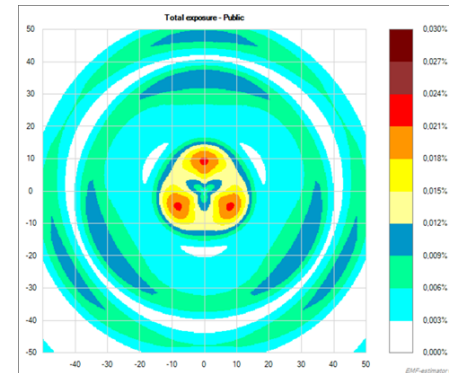
# Sharing infrastructure

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

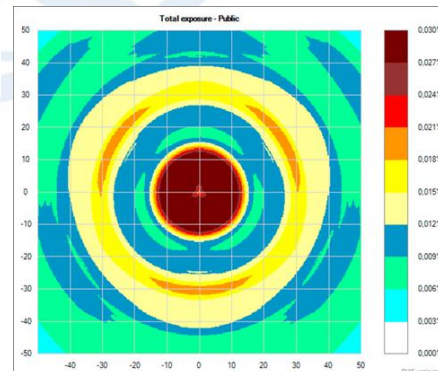
Simultaneous exposure - Public [%]



Base Station A



Base Station B



Base Stations A+B

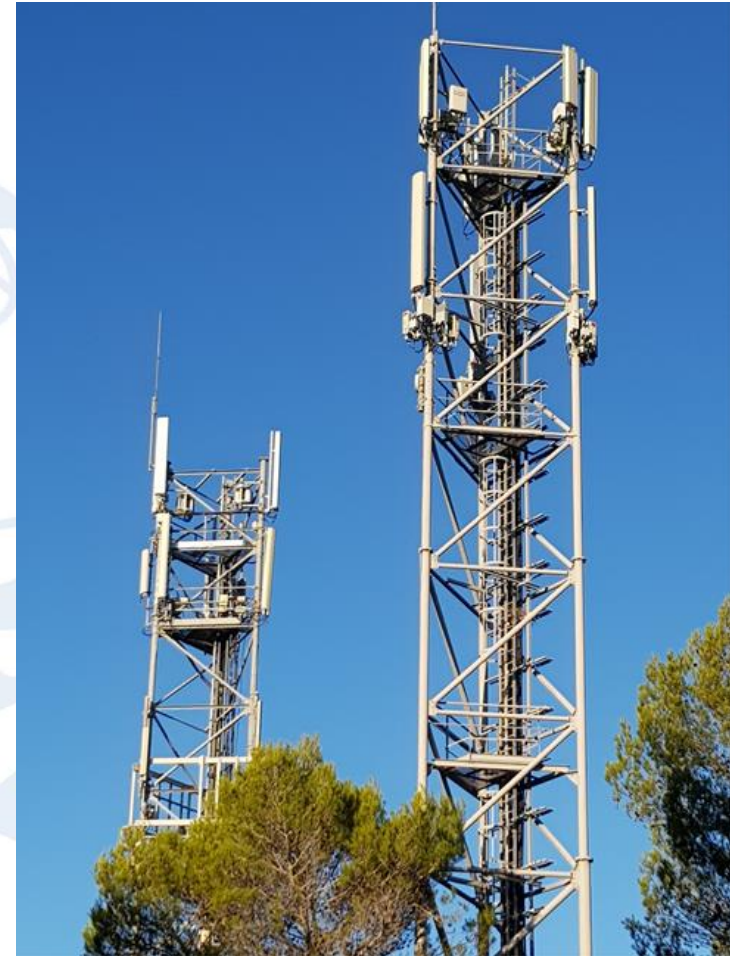
# Internet of things (IoT), M2M

- It is expected that many devices will be connected to the internet using radiowaves. It will allow for many improvements of our life
- It means that the number of radiating sources will increase dramatically
- Almost all such devices will be very low power and short range. 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

- The reduction of the impact on the human exposure to RF EMF is one of the key issues taken into account in 5G system development
- In the first stage of implementation, 5G system may increase the exposure level (it will operate in parallel with older one), but finally exposure to RF EMF should be similar to the current level
- ITU is very active in sharing knowledge and tools concerning assessment of human exposure to RF EMF



# Thank you

## Questions ?

