Lighting the path to 5G

“Electromagnetic field”

December 2020 Warsaw

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EMF Instruments Narda Safety Test Solutions

Measuring instruments for
electric and magnetic fields
broadband or selective
from 0 Hz to 90 GHz

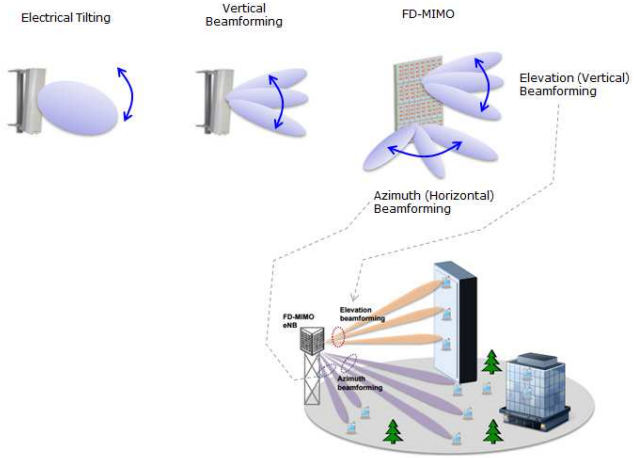
5G Safety measurements

Agenda:

5G Technologies, Beam forming
DSS Dynamic Spectrum sharing
Safety measurements with mMIMO beam forming antennas
FR-2 Band applications

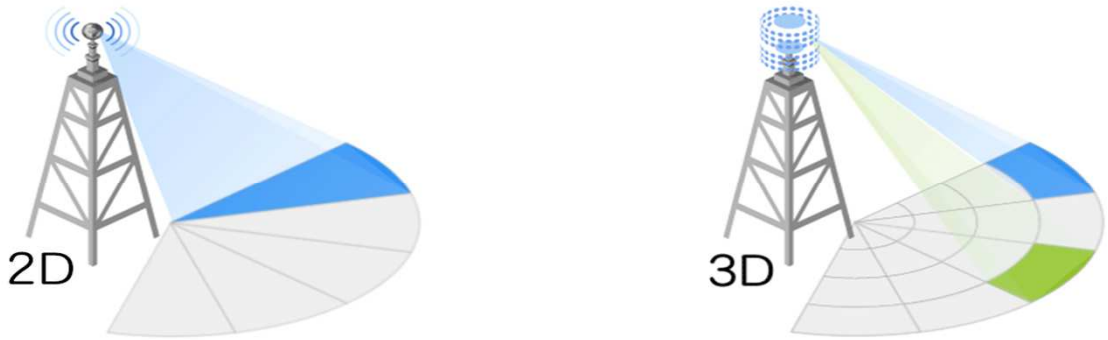
- 5G (short for 5th Generation) is a frequently used term for certain advanced wireless systems.
- Industry association 3GPP defines any system using "5G NR" (5G New Radio) software as "5G“

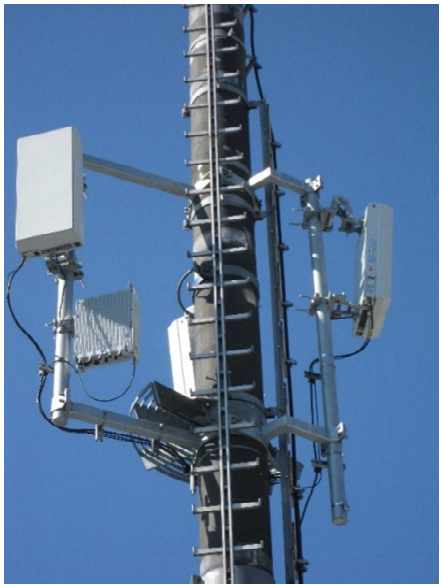
  - FR1 (Frequency Range 1): 410 - 7.125 MHz
  - FR2 (Frequency Range 2): 24.25 - 52.60 GHz



Massive mMIMO and Beamforming

https://www.youtube.com/watch?time_continue=4&v=neSNVBjPIoY&feature=emb_logo





5G Safety measurements

- **5G Variants:**

- Measurements at a site **without mMIMO in DSS (**Dynamic Spectrum sharing) mode together with a LTE signal. The 5G part will be automatically within the result, when you measure and extrapolate the LTE signal in which the 5G part is inserted (typical frequency range 700MHz -2,6GHz)

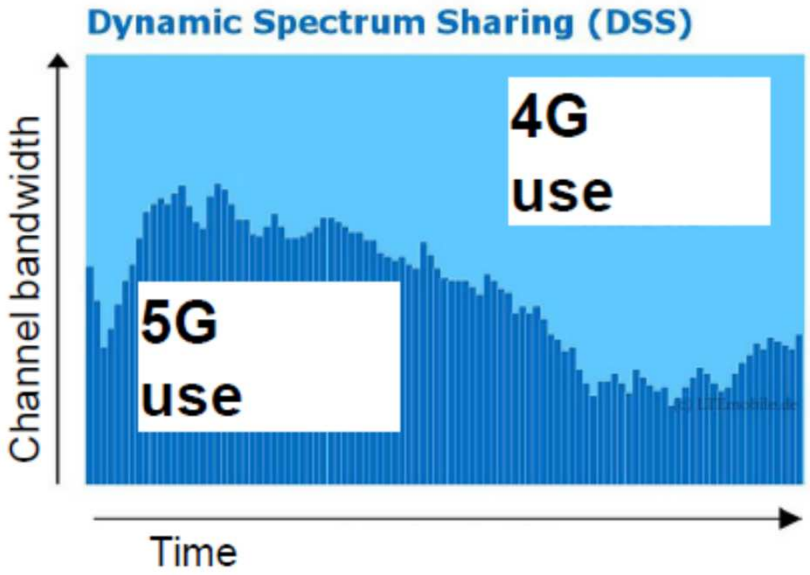
- **Also quite simple:** future pure 5G sites that do **not use mMIMO** antennas e.g. in the lower frequency bands (for rural areas, small cities or suburb regions) or at Small Cell antennas: Code selective measurments of reference signal (SBB) with extrapolation to the full bandwidth similar to LTE. For this only the **decoding option** for the SRM-3006 is needed.

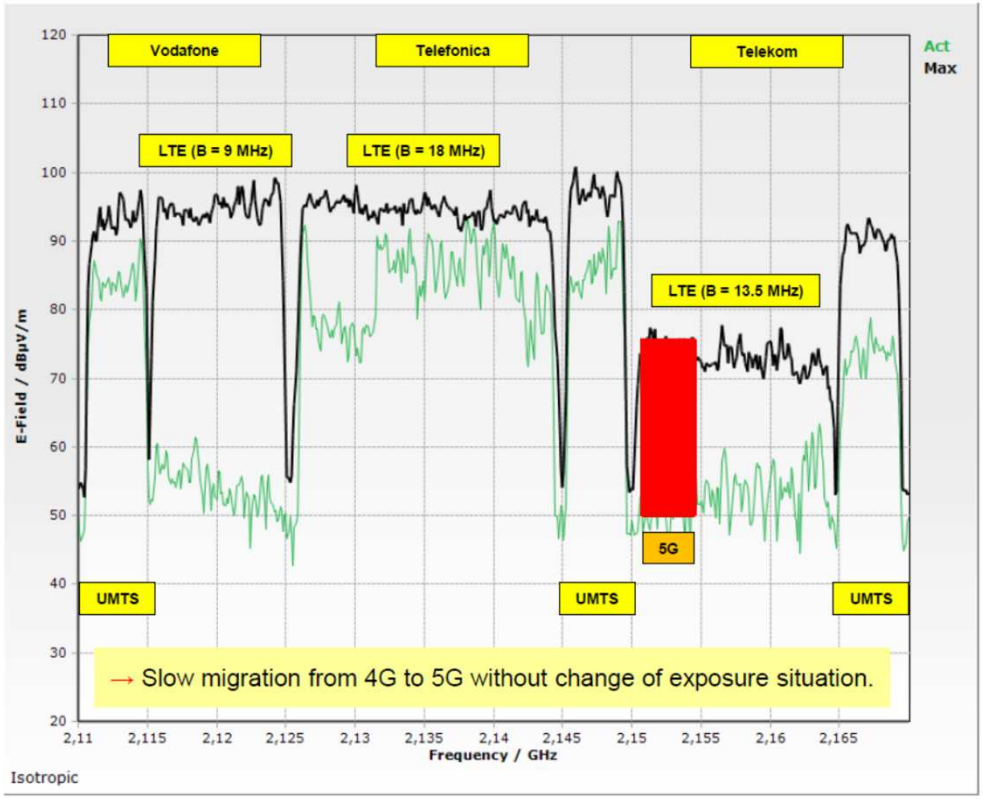
- **New challenge:** Measurements at sites **with mMIMO** antennas (3,6GHz). But also here, the measurement is not the problem (we have to use again the decoding option of the SRM-3006 to measure the SBB). The real challenge is the correct extrapolation to the worst case situation.

5G Safety measurements

- **DSS Example: 5G (DSS in the LTE band 2,7GHz)**

- Most of the 5G locations currently operated in Germany are LTE/5G sites below 3,6GHz in DSS mode without mMIMO.

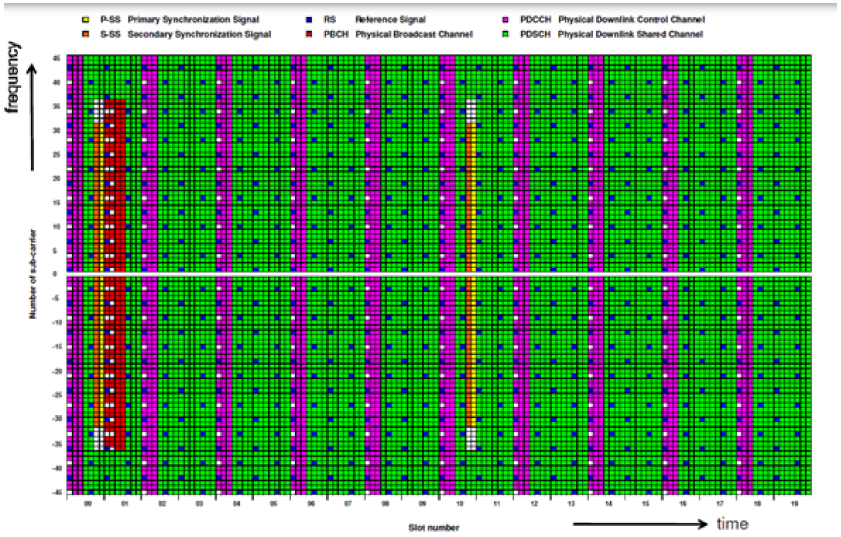




5G Safety measurements

- **Measurements 5G with DSS**

  - We can use the same method as for LTE.
  - Decoding the LTE signal with the decoding option
  - Measuring the RS channels and multiply with the number of charriers



Battery:	Ext. Power	GPS:	48°27'31.7" N	Ant:	---	SrvTbl:	Ger.Funkd.
20.04.12	10:51:01		9°13'48.2" E	Cable:	---	Stnd:	ICNIRP GP

Table View

Index	Cell ID	No. Ant	Act (RS 0)	Act (RS 1)	Act (RS 2)	Act (RS 3)
1	0	1	-3.64 dBm	-999.00 dBm	-999.00 dBm	-999.00 dBm
2	4	2	-5.43 dBm	-5.11 dBm	-999.00 dBm	-999.00 dBm
3	8	4	-7.55 dBm	-7.22 dBm	-6.25 dBm	-5.94 dBm
	Total		-0.49 dBm	-3.03 dBm	-6.25 dBm	-5.94 dBm
	Analog		-11.63 dBm			

Single Axis

LTE

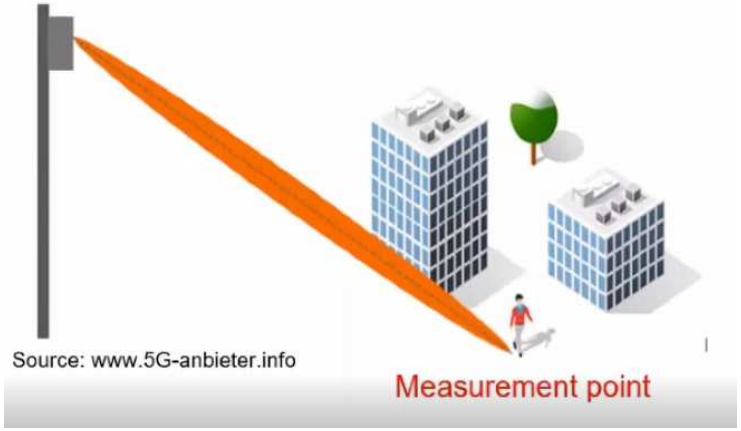
Fcent:	2.654 3 GHz	CBW:	1.4 MHz	Sweep Time:	257 ms	Progress:	
MR:	10 dBm	Extr. Fact.:	1200.000	Noise Suppr.:	Off	No. of Runs:	HOLD
		Cell Sync.:	Sync.	CP Length:	Normal	AVG:	256

5G Safety measurements

- **Measurements 5G with beam forming and mMIMO**

- The **worst case beam** configuration is
- a **single** beam
- Radiating with the **maximum possible power** (EIRP) for longer time towards one measurement point

Example: 3 beams at the same time



- **Measurements 5G with beam forming and mMIMO**

- Forcing a **single beam** towards the measurement location (e.g. by switching a special mode on the base station on or using a device which can generate a very large and reliable data download rate).

- Measuring with a **broadband meter** (e.g. NBM-550), if no other signals are present with significant field strength or (better) measuring over the whole bandwidth (apr. 100MHz) by using the “Safety Evaluation” mode of the SRM-3006 (RBW = 30kHz)

- This techniques only work if you can be sure that only **one single traffic beam** is radiating by the base station antenna during the measurement period. If more beams are present, the measurement result will be lower (due to power sharing between beams)

- This strategy needs **deep support from the operator** because all normal customers must be excluded from the cell during the measurement period.

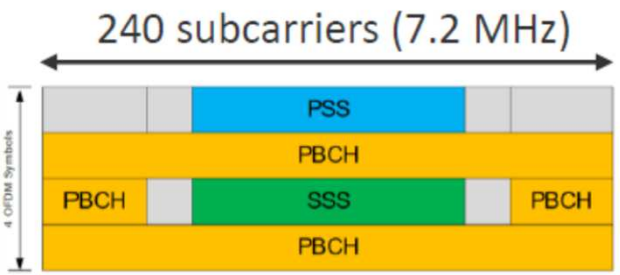
- Therefore the measurement of a **reference signal plus extrapolation** may be the better option, because then a support by the operator during the measurement is not necessary.

5G Safety measurements

- **Measurements 5G with beam forming and mMIMO**

- Suitable measurement and post processing techniques which are based on extrapolation have been already developed for GSM, UMTS, LTE, WiMAX, WiFi….

- Main problem if mMIMO antennas are used, the reference signal is radiated via a **different antenna characteristic** compared to the traffic signal. But the traffic signal is responsible for the maximum exposure.

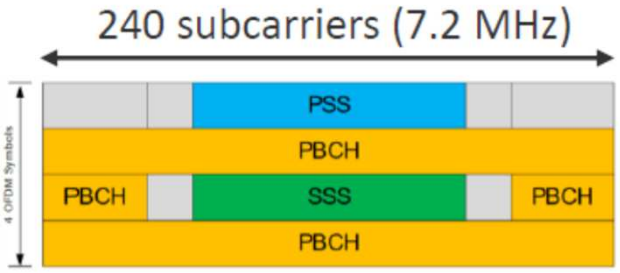


Measurement Concept:

The measurement method is based on the determination of the radiated field produced by the Secondary Synchronization Signal (SSS) or the Primary Signalization Signal (PSS) of the downlink of the Physical Broadcast Channel (PBCH).

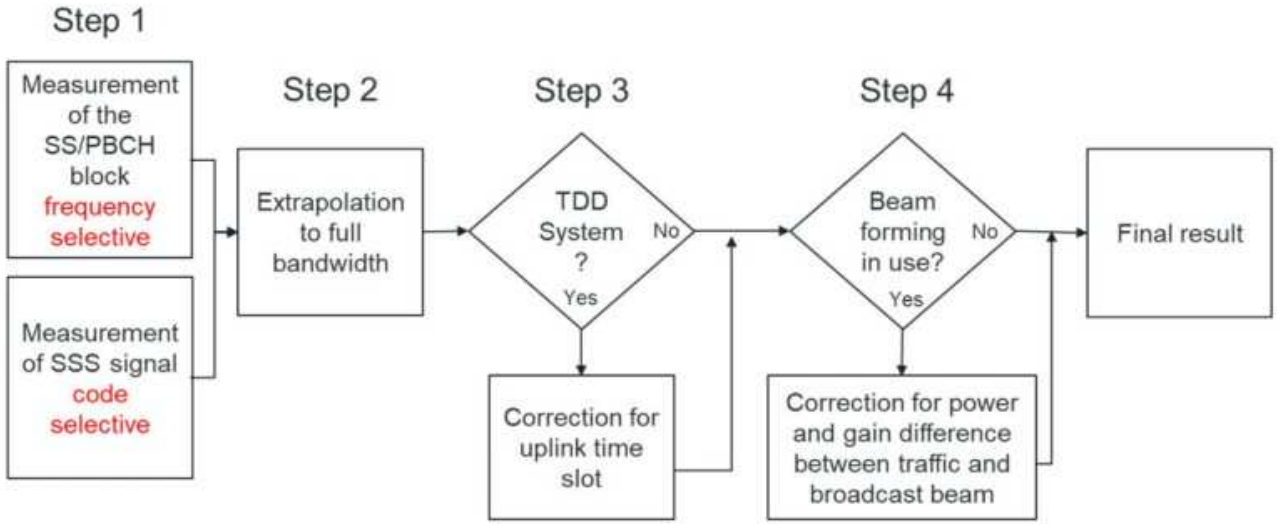
Advantages of the code selective measurement:

- It is independent of traffic situation
- It also works with beamforming
- It can distinguish between different cells
- It does not react on signals emitted by mobile phone
- (important in TDD systems, 5G NR will be mainly used in TDD mode)

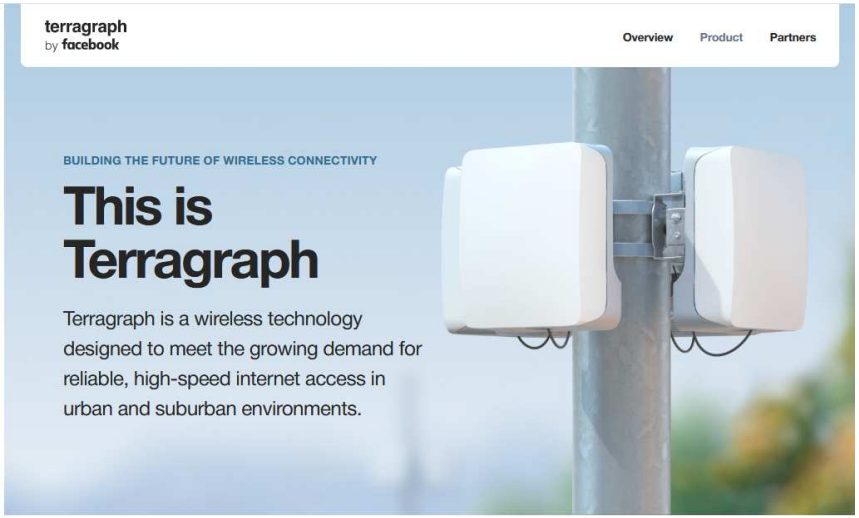


Extrapolation:

For the extrapolation of 5G signals several parameters have to be considered due to the use of TDD and beam forming.



5G Safety measurements



Example: System for "Last Mile" via 60-GHz-Wirless and beam forming

EIRP < 10 Watt; Physical Power in Milliwattrange!
Safety distance: apr. some 10 cm.

Network Results

Terragraph radio nodes leverage abundant high frequency spectrum to bring fast reliable internet to urban and suburban customers.

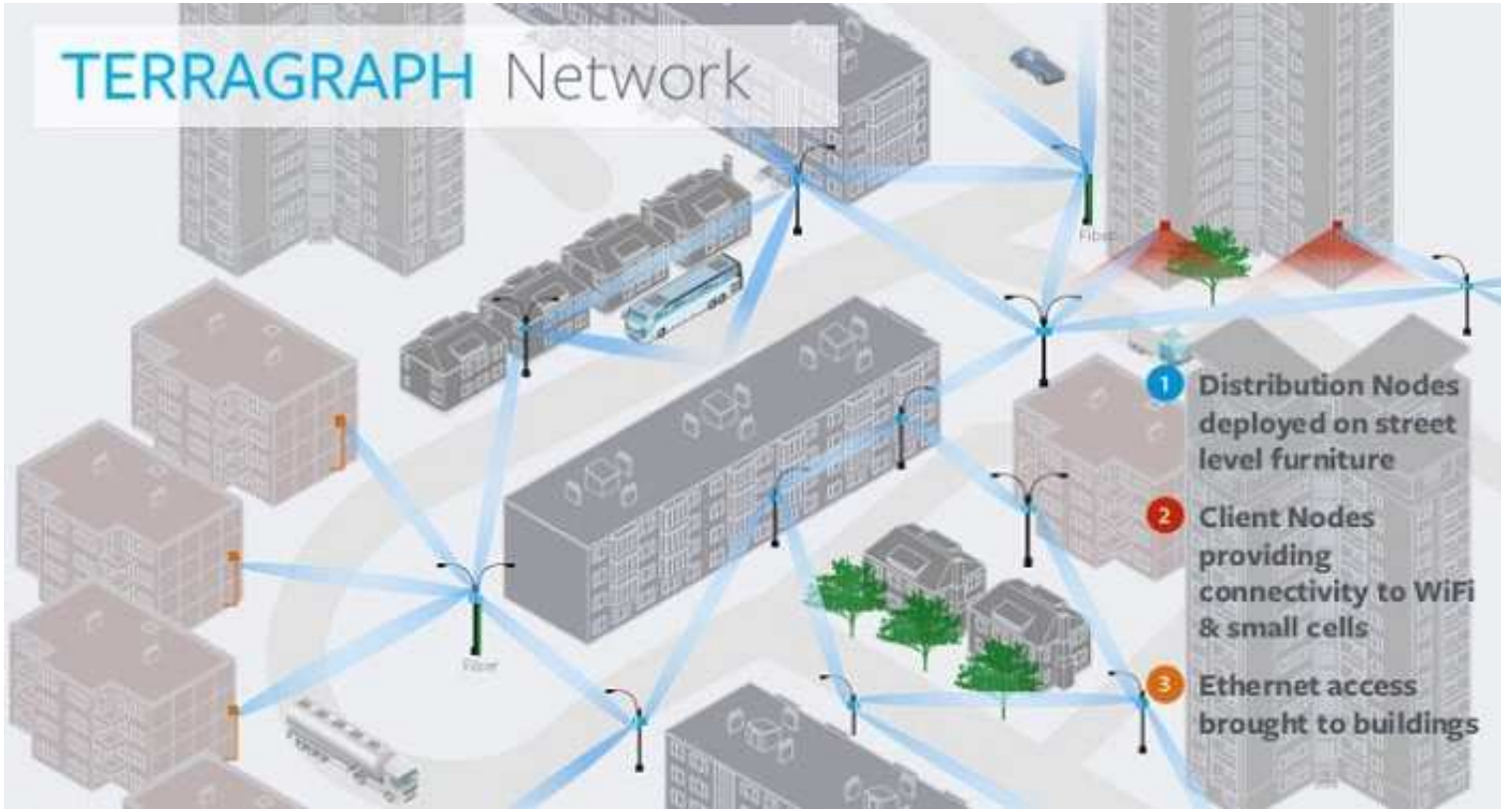
4.6 Gbps
peak data rate in one direction

1 Gbps
average peak user throughput

250m
single link maximum range

5G Safety measurements

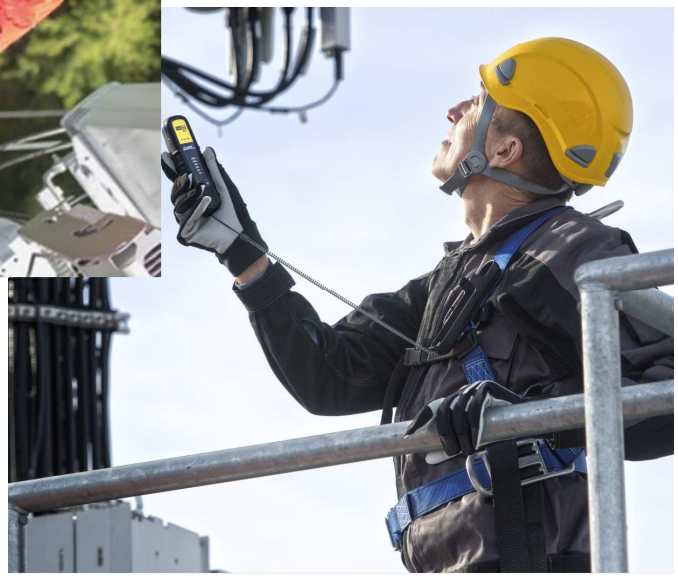
Example: System for "Last Mile" via 60-GHz-Wirless and beam forming



5G Safety measurements

Safety on workplaces solutions
RadMan 2XT in “Isotropic RF detection mode”

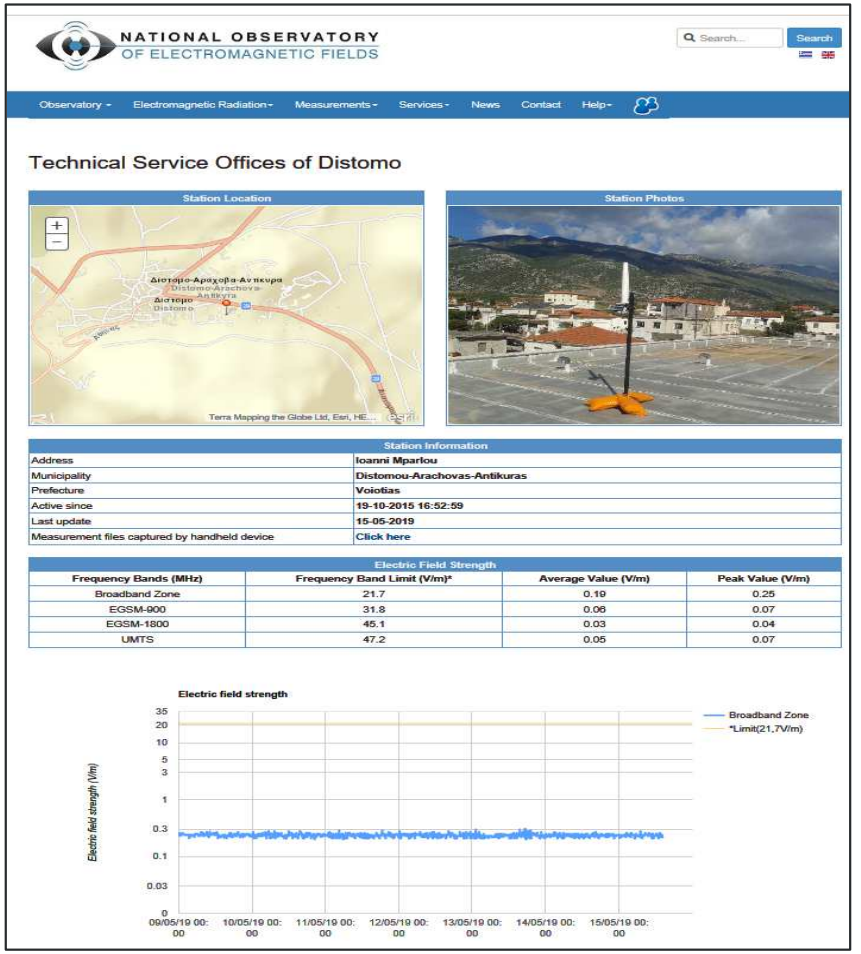
- In telecommunication environment, a response within one second is sufficient
- localization of leaks in waveguides and coaxial screw connectors
- check, if antenna is switched on or off
- tone search to quickly detect leaks or problem areas



5G Safety measurements

Environmental measurements, 24/7 exposure

For 24/7 measurements the area monitor AMB-8059 can measure up to 40 GHz and publish the data into the internet so that public has access to the current radiation level at any time



5G Safety measurements

- **5G Summary:**
- **DSS (**Dynamic Spectrum sharing) mode , measure the LTE with decoding and extrapolation.
- **5G sites** that do **not use mMIMO** antennas. For this only the **decoding option** for the SRM-3006 is needed.
- **5G** sites **with mMIMO** antennas (3,6GHz). Decoding option of the SRM-3006 to measure the SBB.

  The real challenge is the correct extrapolation to the worst case situation.

  Decoding option will be available in December 2020.
  Extrapolation to mMIMO next SW release in 2021.

Thank you very much for your attention!

Do you have additional questions?
If some questions appear later: Do not hesitate to contact me!

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