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Safe use of 5G mobile systems Technology & Standardization aspects

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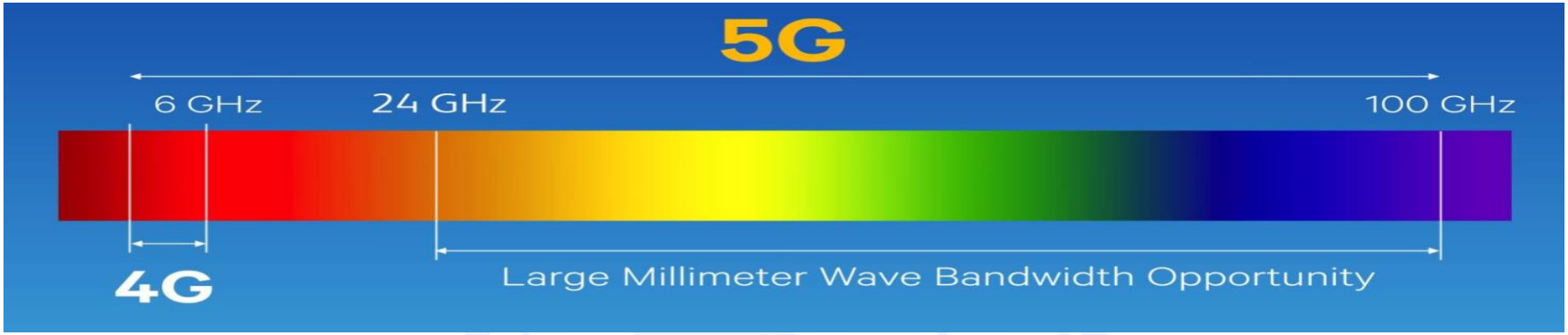
Content

- 5G spectrum & technologies
- Challenges in Mobile Broadband growth
- mmWave EMF Exposure and Compliance Assessment Standardization activities
- Challenges in standardization activities

5G Spectrum



- **Microwaves Wavelength: 300 MHz to 300 GHz (1 m to 1 mm)**

- **Centimeter Waves -Wavelength: 3 to 30 GHz (10 to 1 cm)**
  - Frequency: Also known as Super High Frequency (SHF)
  - Line-of-sight propagation
  - Generally narrow beams

- **Millimeter Waves Wavelength: 30 to 300 GHz (10 to 1 mm)**
  - Also known as Extremely High Frequency (EHF)
  - Line-of-sight propagation
  - Generally narrow beams

5G Technologies

5G Technologies

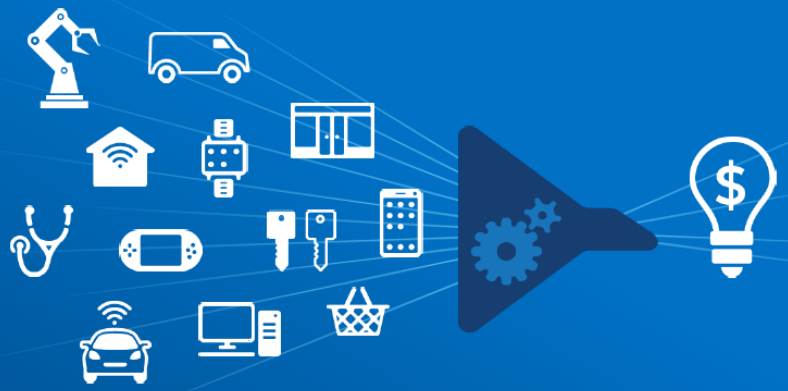
5G IS A CRITICAL ELEMENT OF THE NEW DATA ECONOMY

Connecting billions of devices will generate a massive wave of data. Only 5G has the scale and scope to enable new insights, drive business efficiencies, and create data monetization.

Autonomous Driving
1 GB/second

Smart Hospital
4000 GB/day

Connected Factory
1 million GB/day



intel

5G Technologies

5G Technologies…

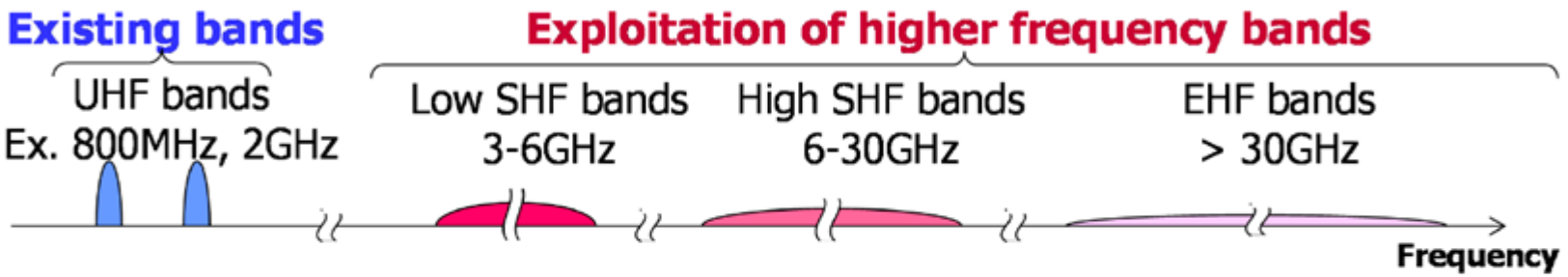
- Massive MIMO 5G technologies

(example: **3 sectors, 4 arrays/sector, 20 antennas/array, Image source: gigaom.com**)

- An example of mm Wave application (Not 5G!) is airport security check scanners (~1 μW/cm2). The main scanners in the active scanner category are mm wave scanners, which emit radio frequencies within the 24–30 GHz frequency range.

5G Technologies…

5G experimental trials are being started since Q4 of 2014



HUAWEI FUJITSU NEC ERICSSON SAMSUNG MITSUBISHI ELECTRIC NOKIA

Key devices/Chip sets vendors

intel QUALCOMM MEDIATEK

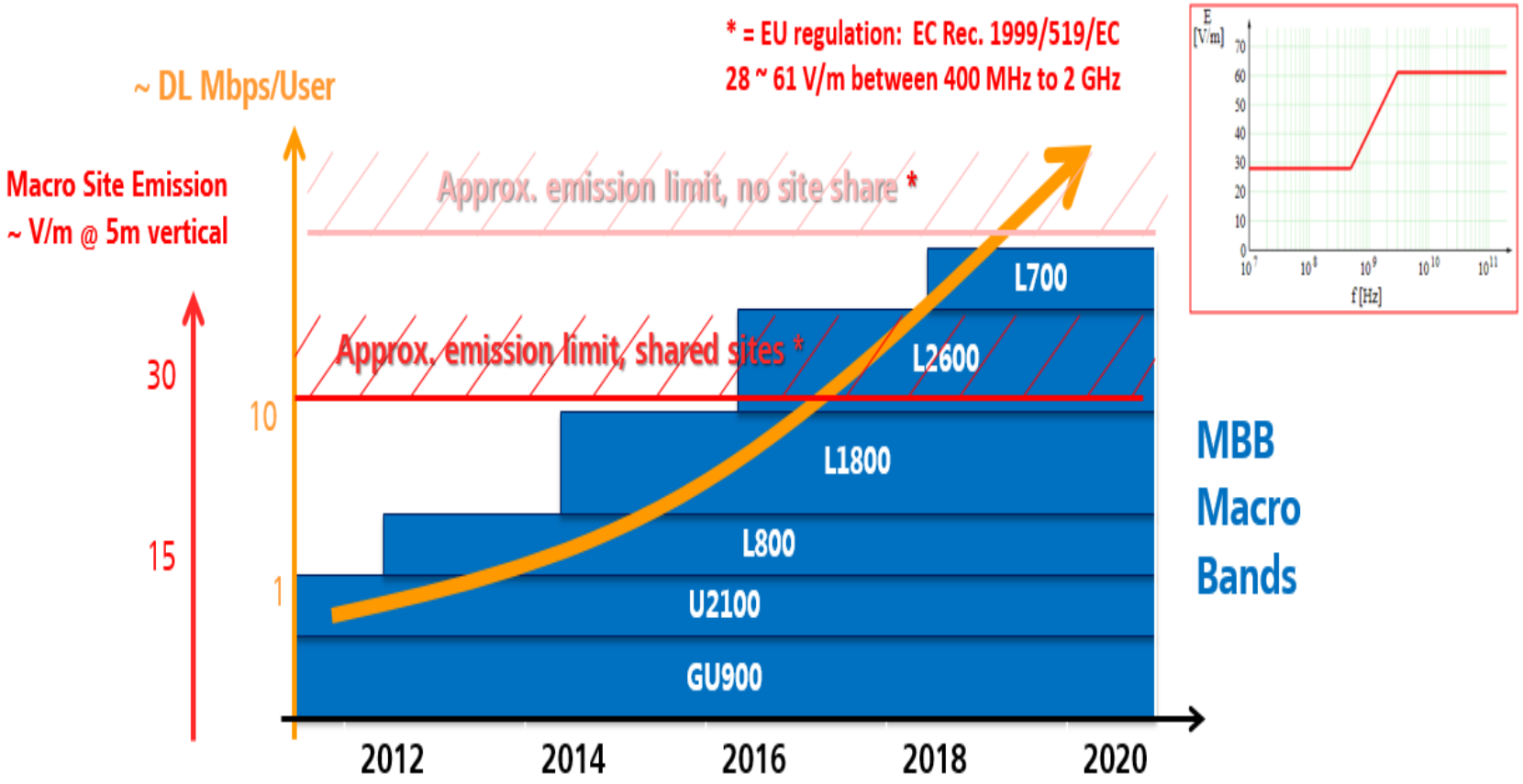
System solution vendors

Panasonic

Measuring instruments vendors

KEYSIGHT TECHNOLOGIES ROHDE&SCHWARZ

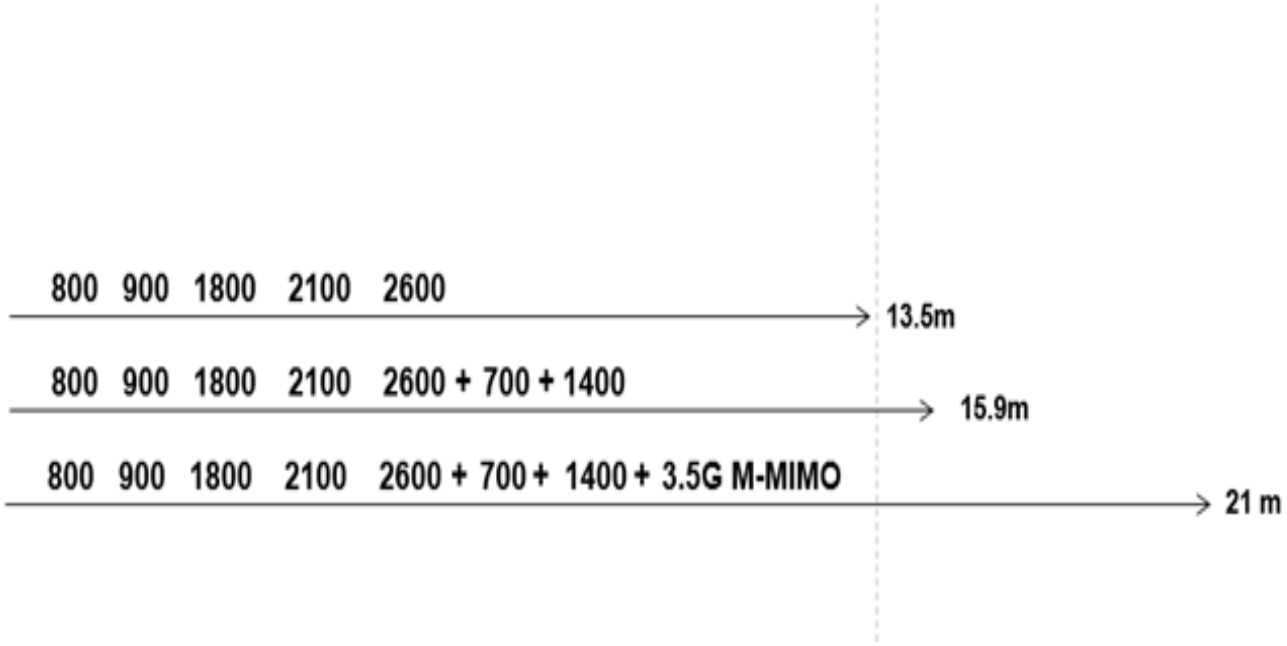
Challenges in Mobile Broadband (MBB) Growth



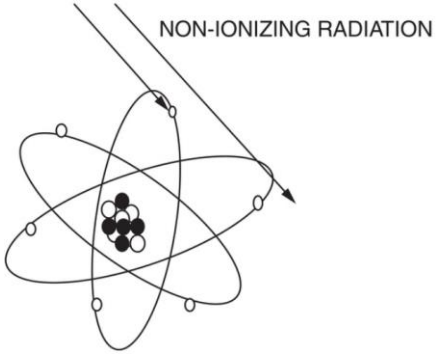
Challenge in Mobile Broadband (MBB) Growth

Exclusive Zone Distance Assessment

Freq (MHz)	Output Power (W)	Max Antenna Gain (dBi)
700	40	15
800	40	16
900	40	16.5
1800	80	17.5
2100	60	18
2600	80	19
1400	80	16.5
3500	120	23 (user beam)



mm Wave EMF Exposure



- Mm Wave radiation is nonionizing because the photon energy is not nearly sufficient to remove an electron from an atom or a molecule.

- According to IEEE International Committee on Electromagnetic Safety (ICES) for frequencies from 3 kHz to 300 GHz: “a review of the extensive literature on radio-frequency (RF) biological effects, consisting of well over 1,300 primary peer-reviewed publications published as early as 1950.

IEEE ICES

mm Wave exposure limits standards

ICNIRP's RF guidelines revision:

- Assumed to be at its final stage.
- Changes with respect to volume shape and power density limits are expected
- The first draft for public consultation is expected by summer 2018.

IEEE C95.1-2005 standard revision:

- Revision incorporates C95.6 (Safety levels, 0 Hz to 3 kHz)
- Stressing harmonization with ICNIRP guidelines
- Expect to initiate TC95 ballot January 2018; IEEE SA ballot mid-year 2018.

The variations of mm Wave exposure limits in various countries

Country/Guidelines	PD Restrictions for the General Public in W/m^2	PD Restrictions for the General Public in mW/cm^2	Frequency Range (GHz)	Basis
ICNIRP [17] (1998)	10	1	2–300	Science based
FCC [16] (1996)	10	1	1.5–100	Science based
China [32] (1987)*	0.1	0.01	0.3–300	Science based
Russia [33] (2003)	0.1	0.01	0.3–300	Science based
Switzerland [34] and [35] (2000)*	0.1	0.01	1.8–300	Precautionary
Italy [36] (2003)*	0.1	0.01	0.0001–300	Precautionary
Typical maximum exposure from cellular base station mounted on 50-m tower (assuming a total effective radiated power of 2,500 W in each sector, summed over all channels)	0.01	0.001	1–2	Example from [29]

*These restrictions only apply to sensitive areas, such as school, hospital, or rooms in buildings, where they are regularly occupied by persons for prolonged periods.

Challenges in the revision of RF exposure standards

- Surface area for mmWave range
- Time average quantification
- Peak values
- Volume shape
- Possible missing scientific studies in support of new concepts

mm Wave Compliance Assessment Standards

IEC TEC106

ITU-T SG5

ITU-R SG1?

IEEE TC34

mm Wave Compliance Assessment Standards

- **IEC TC106 and IEEE TC34 have established two IEEE/IEC joint working groups on 5G technologies compliance assessment are established**
  - IEC/IEEE JWG to develop a dual logo standard for the assessment of power density in close proximity to the head and body by **measurement** from 6-100GHz
  - IEC/IEEE JWG to develop a dual logo standard for the assessment of power density in close proximity to the head and body by **computational** methods from 6-300GHz.
- **ITU-T SG5 is closely collaborating with IEC TC106 and IEEE TC34 to harmonize the 5G related compliance assessment related standards development**

Challenges in the assessment of mm Wave near fields

- **Electric field or temperature probe based systems**
  - Measurement of E field components within a few millimeters of the surface.
  - coarse resolution
  - not capable of measuring the absolute E field phase which is necessary for multi-element antenna systems.
- **Array E field probe systems**
  - interaction with the DUT
  - Extrapolation are needed for computation

Thank you for your attention

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