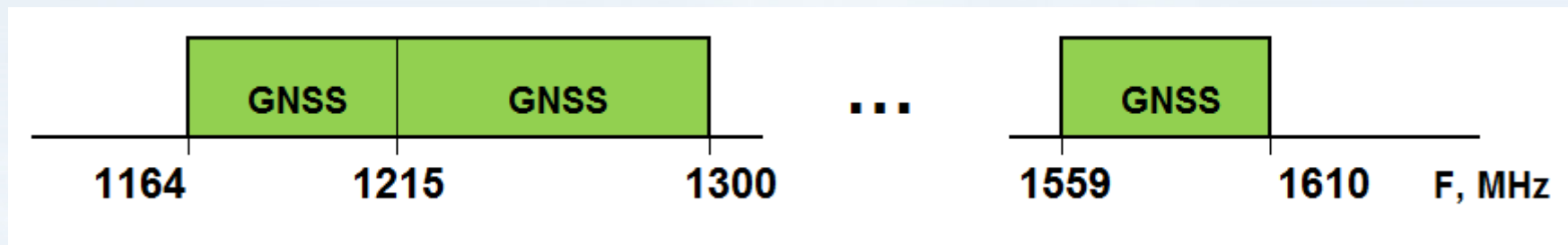


# Protection of GNSS spectrum

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Vienna, Austria 7 – 10 May 2016

## Basic GNSS frequency bands

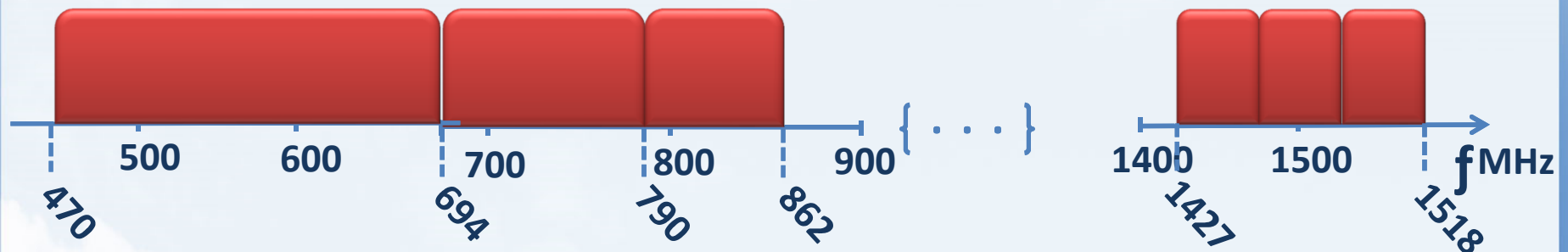


Global navigation satellite systems operate in the radionavigation satellite service

No.1.43 Radio Regulations: «radionavigation-satellite service is a radiodetermination-satellite service used for the purpose of radionavigation»

No.4.10 Radio Regulations: «Member States recognize that the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference; it is necessary therefore to take this factor into account in the assignment and use of frequencies»

## The frequency bands identified for IMT

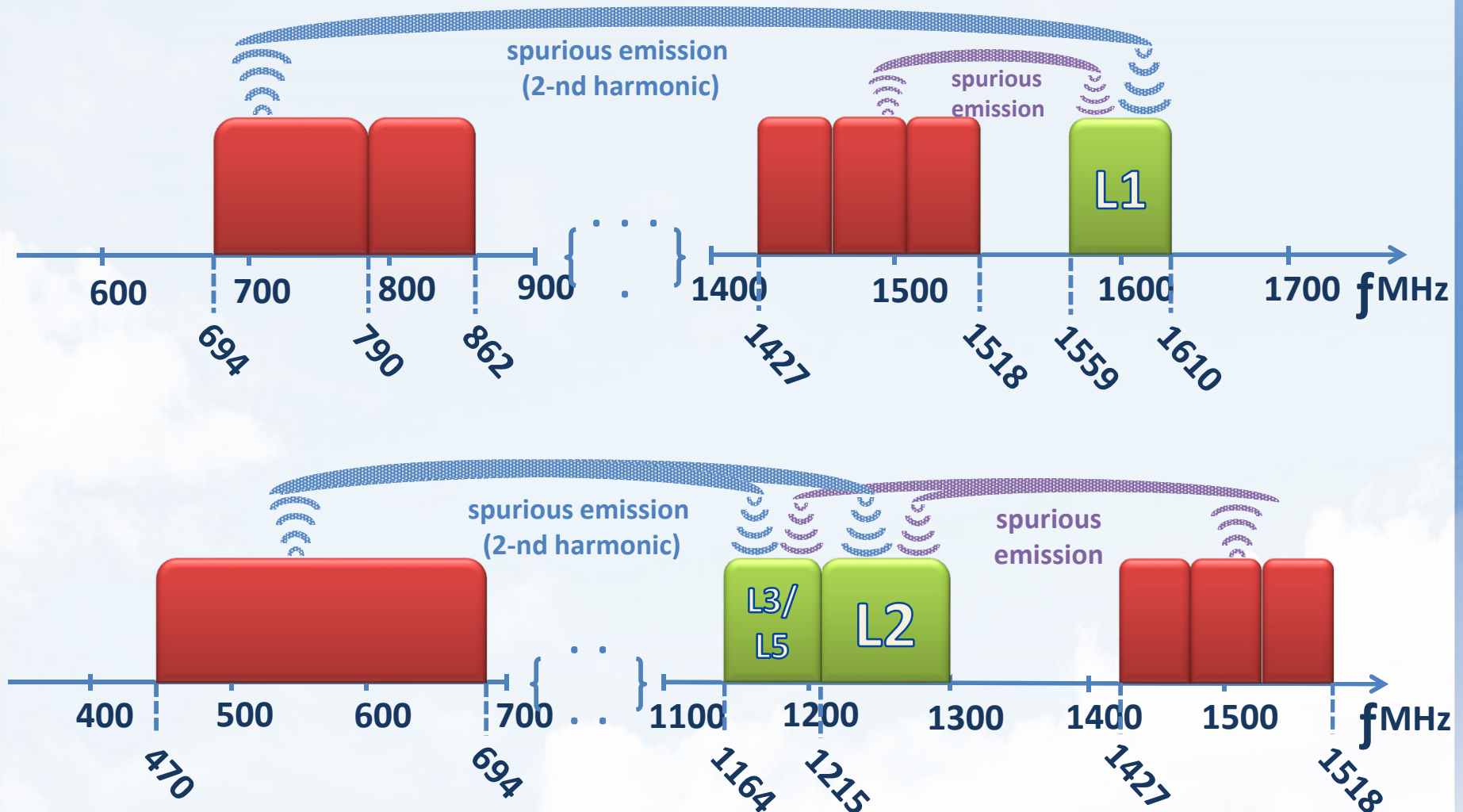


WRC-2012 and WRC-2015 resolved to identify the following frequency bands for the IMT systems:

470-694 MHz, 694-790 MHz, 790-862 MHz and 1427-1518 MHz.

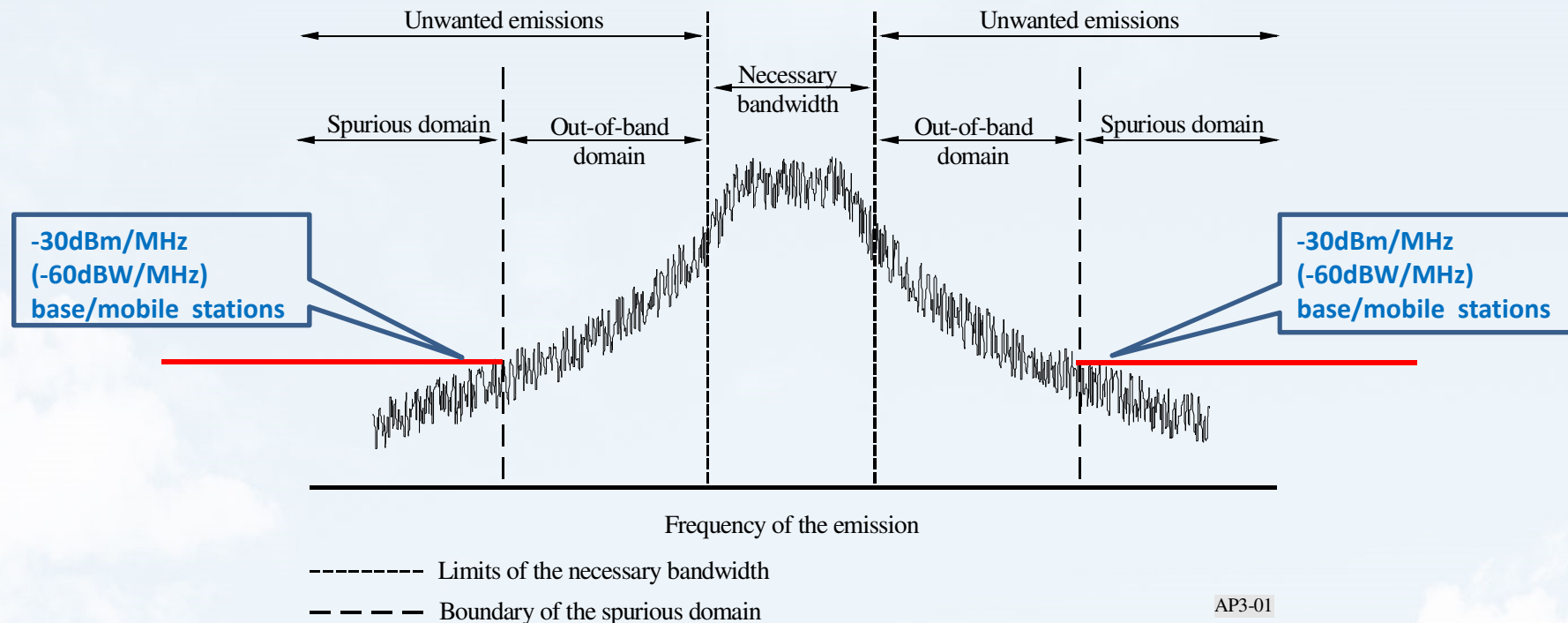
The frequency band identification for IMT was a global one for some of the mentioned bands.

# Potential impact from IMT frequency bands to GNSS frequency bands



# IMT unwanted emissions limits

## Out-of-band and spurious domains



- ✓ Recommendation ITU-R M.2070 «Generic unwanted emission characteristics of base stations using the terrestrial radio interfaces of IMT-Advanced»
- ✓ Recommendation ITU-R M.2071 «Generic unwanted emission characteristics of mobile stations using the terrestrial radio interfaces of IMT-Advanced»

## Protection criteria for GNSS receivers in L-band

- Recommendation ITU-R M.1902 «Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) operating in the band 1 215- 1 300 MHz»;
- Recommendation ITU-R M.1903 «Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) and receivers in the aeronautical radionavigation service operating in the band 1 559-1 610 MHz»;
- Recommendation ITU-R M.1905 «Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) operating in the band 1 164- 1 215 MHz».

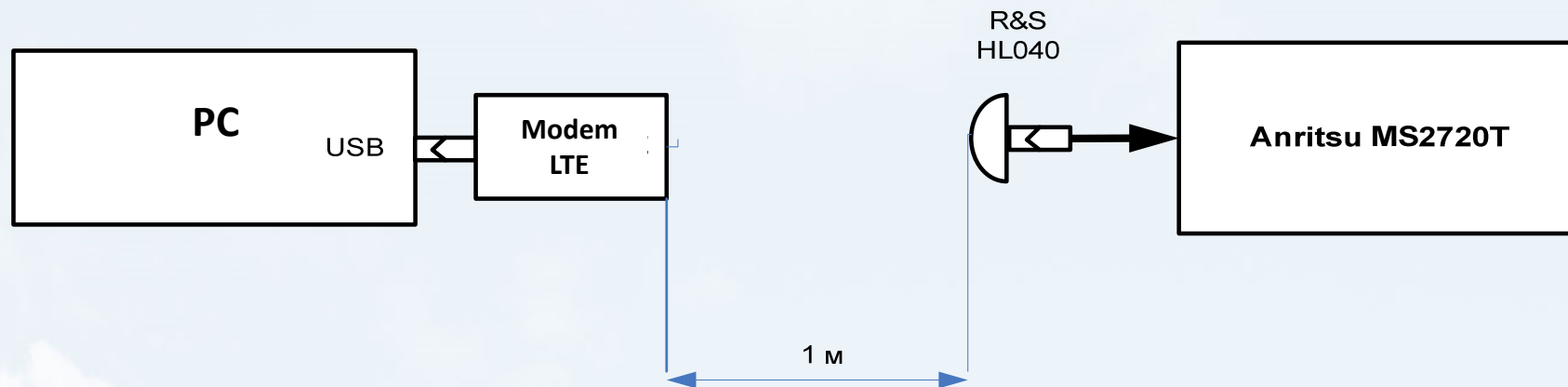


## Interference evaluation from IMT into GNSS

	L1		L2		L3	
Spurious emissions level (dB(W/MHz))	-60					
Maximum receiver antenna gain (dBi)	6	6	6	6	7	3
Acquisition mode threshold power density level of aggregate wideband interference at the passive antenna output (dB(W/MHz))	-142	-148	-127	-156	-146	-156
Power density level at the antenna output (dB(W/MHz))	-54	-54	-54	-54	-53	-57
Required attenuation (dB)	88	94	73	102	93	99

**The required mitigation of unwanted emissions from IMT base and mobile stations would be of 73-102 dB in different frequency bands.**

## Full-scale experiment

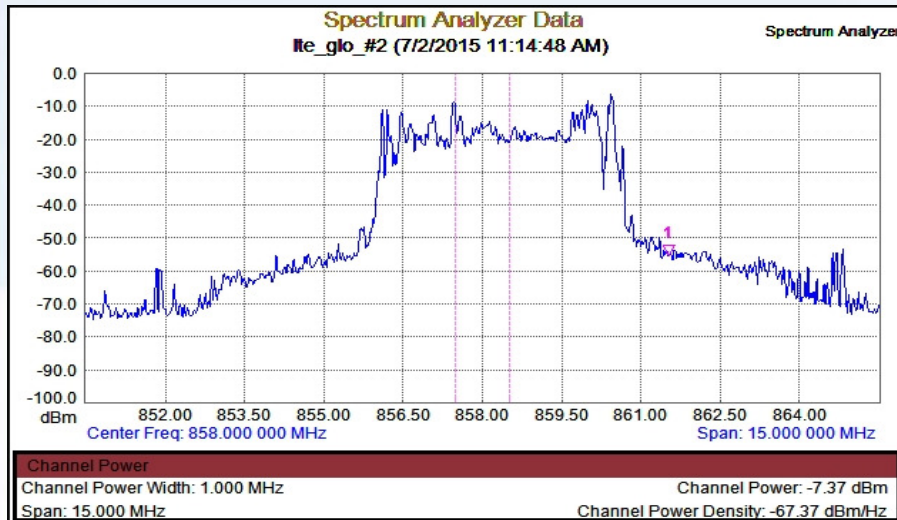


### The full-scale experiment instrumentation:

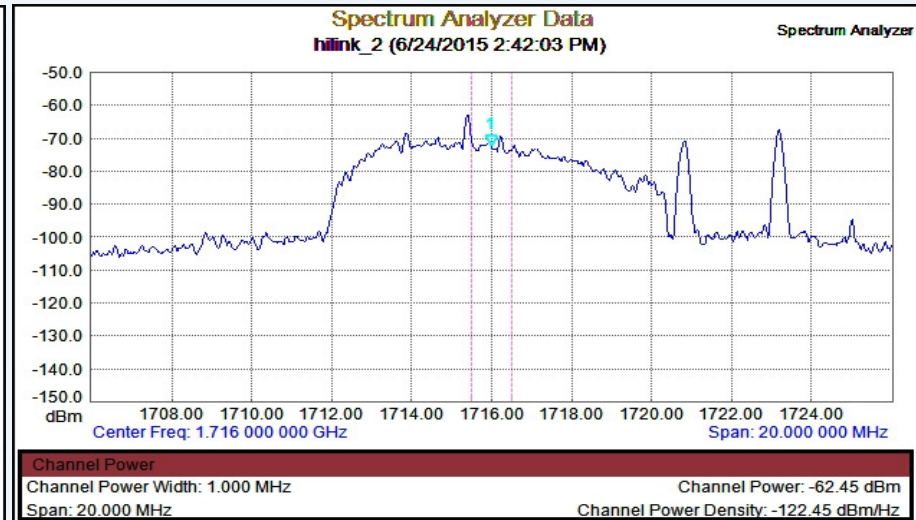
- ANRITSU MS2720T spectrum analyzer;
- R&S HL040 antenna;
- calibrated HF-cables;
- HUAWEI: LTE USB 822FT modem.



# Interference evaluation from IMT into GNSS (full-scale experiment)



Measurement Parameters			
Trace Mode	Max Hold	Frequency Span	15.000 000 MHz
Preamp	OFF	Reference Level	0.000 dBm
Min Sweep Time	1 S	Scale	10.0 dB/div
Reference Level Offset	0.0 dB	Operator Name	
Input Attenuation	20.0 dB	Tower	
RBW	100.0 kHz	Serial Number	829126
VBW	30.0 kHz	Base Ver.	V4.13
Detection	RMS	App Ver.	V5.32
Center Frequency	858.000 000 MHz	Model	MS2724B
Start Frequency	850.500 000 MHz	Options	9, 19, 25, 27, 31, 33, 34...
Stop Frequency	865.500 000 MHz	Date	7/2/2015 11:14:48 AM
		Device Name	



Measurement Parameters			
Trace Mode	Max Hold	Frequency Span	20.000 000 MHz
Preamp	ON	Reference Level	-50.000 dBm
Min Sweep Time	0.001 S	Scale	10.0 dB/div
Reference Level Offset	0.0 dB	Operator Name	
Input Attenuation	0.0 dB	Tower	
RBW	100.0 kHz	Serial Number	1311029
VBW	30.0 kHz	Base Ver.	V4.88
Detection	RMS	App Ver.	V6.30
Center Frequency	1.716 000 GHz	Model	MS2720T
Start Frequency	1.706 000 GHz	Options	9, 31, 720, 820
Stop Frequency	1.726 000 GHz	Date	6/24/2015 2:42:03 PM
		Device Name	

$$P_{out} = P_{meas} + G_{ant} - N_{cab} - P_{fs}$$

where:

$$P_{fs} = 20 \lg D + 20 \lg F + 32,45$$

The level of IMT user terminals spurious emissions at the second harmonic frequency would be of minus 61.31 dBW/MHz

## Summary

The experiment results showed that unwanted emissions from IMT base and mobile stations could cause harmful interference to operation of the GNSS receiving stations in the frequency bands 1 164 -1 300 MHz and 1 559-1 610 MHz.

# Proposals

It is proposed to consider the modifications of Recommendation 9A.2.1 :

## «IMT-GNSS Compatibility

- ICG members are encouraged to actively participate in the ITU-R and regional ~~WRC-15 preparatory~~ work on new IMT spectrum allocations to ensure that proposals do not impact existing and future GNSS operations.
- The ICG members are recommended, ~~when considering candidate bands for IMT below 3 GHz,~~ to encourage their administrations to ensure the protection of RDSS/RNSS from the unwanted emissions of new IMT spectrum allocations ~~from these candidate bands,~~ including adjacent band interference, spurious interference and harmonic interference, as a result may require the implementation of more stringent limits for IMT unwanted emissions levels in RDSS/RNSS bands.
- Members may also consider forming links with other satellite groups already defending satellite spectrum.

**Thank you for your attention!**

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