Radiocommunication Study Groups

Received: 7 February 2014

Document 4-5-6-7/427-E
10 February 2014
English only

France

SHARING STUDIES BETWEEN AERONAUTICAL TELEMETRY TERRESTRIAL SYSTEMS AND IMT SYSTEMS WITHIN 1 427-1 492 MHZ BAND

1 Introduction

Telemetry systems described in Attachment 3 to Annex 6 to Document 4-5-6-7/242 are composed of ground stations and airborne stations. In Europe, the deployment of aeronautical telemetry services is limited to some CEPT countries, in accordance with ITU Radio Regulations footnote No. **5.342**.

As stated in the same document when referring the issue of the protection of onboard receivers of the aeronautical telemetry in this frequency band, *it should be noted that these links could be considered as telecommand, not telemetry, under the CPM text for WRC-03 agenda item 1.31. That is why RR No.* ***5.342*** *could be viewed as not justifying the protection of telecommand links and their associated airborne receivers used by administrations listed in RR No.* ***5.342****.*

For this reason, this document only presents study results of interference impact caused by the possible stations of the mobile service to ground receivers of aeronautical telemetry in the frequency band 1 427-1 492 MHz that are notified in the BRIFIC. In terrestrial telemetry system, telemetry signals are transmitted by airborne stations (e.g. aircraft, missile) to ground stations.

2 Protection criteria for the aeronautical telemetry stations in the frequency band 1 429-1 535 MHz

The protection criteria for the terrestrial aeronautical telemetry systems are given in Recommendation ITU-R M.1459.

In particular for their protection in the frequency band 1 452-1 525 MHz the power flux-density (pfd) of geostationary satellites BSS or MSS in the reference bandwidth of 4 kHz for all methods of modulation should not exceed:

–181.0 dB(W/m²)		for	$0° \leq \alpha \leq 4°$;
$-193.0 + 20 \log \alpha$	dB(W/m²)	for	$4° < \alpha \leq 20°$;
$-213.3 + 35.6 \log \alpha$	dB(W/m²)	for	$20° < \alpha \leq 60°$;
–150.0 dB(W/m²)		for	$60° < \alpha \leq 90°$

where α is the angle of arrival of the interfering signal (degrees above the horizontal plane).

These criteria were also used for the protection of the aeronautical telemetry stations in the frequency band 1 430-1 432 MHz in the studies on WRC-07 agenda item 1.17 (see CPM-07 Report Section 3/1.17/2.2).

It appears relevant to extend such assumption to adjacent bands: 1 432-1 452 MHz and 1 427-1 430 MHz, so that the same protection criteria will cover the whole 1 427-1 492 MHz band for sharing studies.

3 Systems characteristics

a) Telemetry systems

Parameters from telemetry ground receivers for sharing studies are extracted from Recommendation ITU-R M.1459 and Attachment 3 to Annex 6 to Document 4-5-6-7/242 as seen in the table below:

TABLE 1

Telemetry ground stations characteristics

Parameters	Unit	Value
Receiver antenna gain	dBi	20-41.2
Ground station antenna height	m	10
Transmitter frequency range	MHz	1 429-1 492

b) IMT systems

In this contribution, the considered bands for possible IMT identification on L-Band (1 427-1 452 MHz and 1 452-1 492 MHz) are for Supplementary DownLink (SDL), which impacts base stations (BS) as IMT Transmitters. Thus, features of the BS system extracted from Document 4-5-6-7/236[1] are provided in the Table 2.

TABLE 2

Mobile systems characteristics

Parameters	Unit	Value
Transmitter bandwidth	MHz	10
Transmitter base station antenna gain	dBi	18
Base station emission power	dBm	46
Base station downtilt	°	3-6
Base station feeder loss	dB	3
Base station antenna height h_e	m	30
Transmitter frequency range	MHz	1 427-1 492

[1] Submitted by WP 5D in LS to JTG 4-5-6-7.

c) Assumption and methodology

A minimum coupling loss approach is used, modeling only a single interferer-victim pair (as to be BS-to-Radar) and corresponding to the worst case scenario with main lobe (of the interferer transmitter antenna pattern) to *Main Lobe ML* (of the radar receiver antenna pattern) configuration (ML-ML) in the horizontal plane. From this method, we derive the InBand (IB) emissions level of IMT systems when telemetry ground stations and IMT Base Stations (BS) share 1 427-1 492 MHz band.

Equation (8) of Recommendation ITU-R M.1459 provides a methodology to calculate the maximal acceptable interference level at the receiver, from pfd limit:

$$Pfd \leq \frac{4\pi \times Imax}{G_0 \lambda^2}$$

where:

– Pfd: power flux density of the interferer ($W/(m^2.B)$;

– I_{max} : maximal acceptable Interference level after the antenna the receiver (dBm);

– G_o : Telemetry receiver antenna gain in the direction of the Base station.

From this expression, we deduce[2] the required isolation to ensure the sharing between the telemetry receiver and BS transmitter:

$$\text{Isolation(dB)} \geq \text{PathLoss(dB)} = \text{Pfd(dBm/4 kHz/m}^2\text{)} + 10\log10(\frac{\lambda^2}{4\pi}) - \text{e.i.r.p.}_{BS}\text{(dBm)}$$

The propagation model between the telemetry ground receiver and the base station is extracted from Recommendation ITU-R P.452-14. The selected propagation model separating the telemetry receiver from the base station is terrestrial point-to-point propagation model which is suitable over any kind of terrestrial areas since it accounts the digital terrain model featuring the relief of the location of both transmitter and receiver. Associated parameter to the propagation model is the time for which the pathloss assessment is higher or equal is time p= 50%.

4 Practical analysis of the separation distance between ground telemetry station and LTE Base Station

a) Required isolation between ground telemetry station and IMT Base Stations

Table 3 depicts the required isolation in propagation to protect terrestrial telemetry receiver from interfering BS transmitter, given the arrival angles range. According to the downtilt value taken by IMT BS, the angle of arrival belongs to the 0-6° range, leading to minimum isolation value as to be 200dB.

TABLE 3

Required isolation between ground telemetry station and IMT BS

Arrival angle range (°)	0-4	4-20

[2] $I_{max}(dBm)=EIRP_{BS}(dBm) + PathLoss(dB)+G_o(dBi)$

Required pathloss (dB)	200	200-186

From this value, we may derive the separation distance, in accordance with our previous assumptions on the propagation model.

b) Declared ground telemetry stations in BRIFIC

If the ground telemetry station is receiver, it means that the transmitter is an airborne device, which is labelled as MA (for aircraft transmitting station). The BR-IFIC lists 56 assignments for such devices over 1 427-1 525 MHz range with 4 different frequencies channels (1 439.65 MHz, 1 460.9 MHz, 1 482.15 MHz and 1 503.35 MHz) that are recorded for each geographical site. Thus, it leads to 14 different geographical terrestrial telemetry sites.

c) Sharing results WITHOUT mitigation techniques

The following table depicts for the 14 recorder assignments whether or not the ground telemetry station is protected when IMT base stations are located in the cross-border. They are sorted by capital letter (from A to N) for the later study. The minimum PathLoss (column 3) from the cross-border to the ground telemetry station is displayed in order to ease comparison with the required pathloss (200 dB) with reference to the concerned crossborder country for each recorded assignments. This results in the last column if any “Required additional isolation dB” is mandatory.

The yellow rows depict the case where the declared ground telemetry station has been already protected at the cross-border without any mitigation techniques (separation distance, site shielding, sector disabling, down tilting…): in order to be protected, 4/14 sites do not require any mitigation techniques to apply on IMT base stations (BS).

The blue rows correspond to the notified sites which have no data related on the digital terrain model from the NASA Shuttle Radar Topography Mission (SRTM)[3]: no path loss can be calculated for such sites: 3/14 cannot be calculated. However 2/3 are at least 980 km away from the cross border which lead to the conclusion that the required isolation to protect ground telemetry station is met for 2/3 sites which have no SRTM data.

The green field indicates which ground telemetry station does not require any additional isolation to be protected from BS interference.

[3] Available for download at: http://dds.cr.usgs.gov/srtm/version2_1/SRTM3/Eurasia/

TABLE 4

Preliminary conclusion: Thus, 6/14 sites do not require any additional isolation to be protected from the interfering LTE Base Stations (green color for the last column).

Number	Coordinates of the ground telemetry stations	D* Distance between crossborder and ground telemetry station minimizing the pathloss	Path Loss (dB) from the frontier to the ground telemetry station	Required Additional Isolation (dB)
A	91°23'00"E - 53°45'00"N	322km- (Kazahkstan)	288.9	NO
B	47°52'00"E - 46°24'00"N	54km- (Kazakhstan)	161	39
C	83°34'00"E - 53°22'00"N	245km- (Kazakhstan)	214.6	NO
D	38°13'00"E - 46°41'00"N	181km (Ukrain)	198	2
E	20°24'00"E - 54°46'00"N	45km (Poland) 70km (Lithuania)	132 177	68 23
F	32°10'00"E - 52°20'00"N	28km (Ukrain)	146.5	53.4
G	65°25'00"E - 55°29'00"N	92km (Kazakhstan)	191.6	8.4
H	73°34'00"E - 54°59'00"N	105km (Kazakhstan)	194	6
I	28°24'00"E - 57°47'00"N	37km (Estonia) 60km Latvia)	149 163	51 37
J	44°36'00"E - 43°13'00"N	50km(Georgia)	208	NO
K	30°22'00"E - 66°58'00"N	58km (Finland) 239km (Norway)	No SRTM available	
L	61°34'00"E - 69°46'00"N	1162km (Finland-Norway)	No SRTM available	NO
M	53°07'00"E - 67°38'00"N	980km (Finland-Norway)	No STRM available	NO
N	57°19'00"E - 52°02'00"N	102km Kazakhstan	223	NO

There is a need to investigate for the 7[4] remaining telemetry ground stations (that have been notified in the BR IFIC) the impact of the BS interference on them.

[4] There should be 8 but one of them (number K) does not have the SRTM data to calculate the required separation distance.

d) Sharing results WITH mitigation techniques

There are different mitigation techniques which may be applicable for cochannel operation between ground telemetry receivers and IMT BS. In order to select the most suitable mitigation technique for each case, it is proposed to sort cases according to their required additional isolation ranges:

– required additional isolation 0-9dB: downtilt antenna from 3° to 6°.

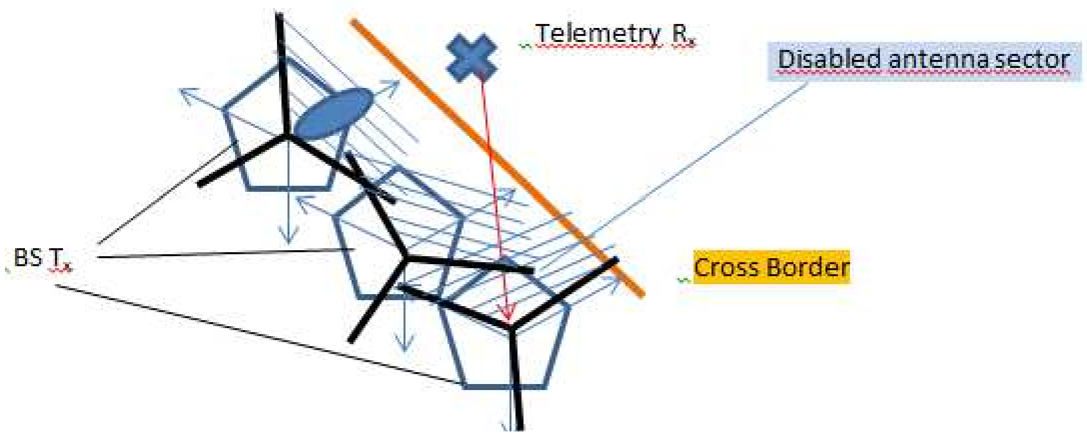
Case	Required additional isolation (dB)	Required additional isolation (dB) after additional downtilt antenna	Separation distance to the cross border (km) after mitigation techniques
D	2	0	0
G	8.4	2.8	7
H	6	0.4	1.5

– required additional isolation >9 dB: disabling sector and/or site antenna depointing to very local low gain value (for the BS):

α) when disabling the sector antenna, the 2 other ones (see Figure) are the main interfering components onto the telemetry ground station. The following figure depicts that any BS in the vicinity of the cross-border may face the radar main beam with the disabled antenna sector and thus the backlobes of the 2 active sectors facing the Telemetry ground receiver lead to 20dB antenna gain discrimination.

FIGURE1

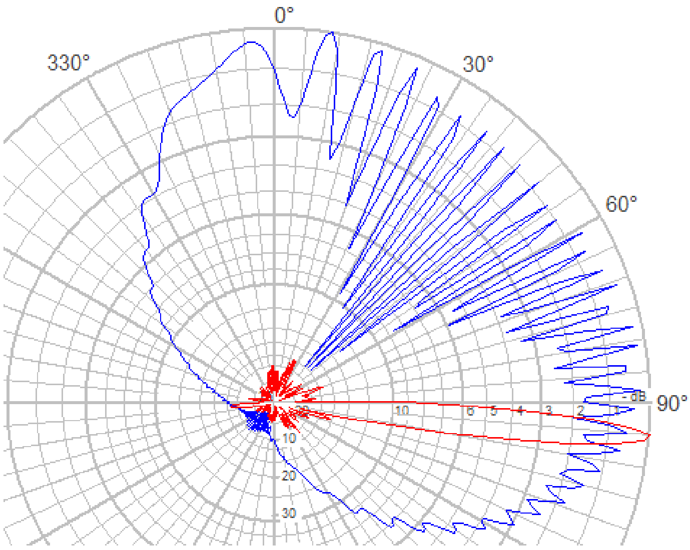
Overview on sector disabling



β) harmful interference is avoided if the IMT-Advanced base station antennas can have nulling in the direction of the radar. Such nulling could be of the order of 20 dB antenna gain discrimination, as depicted by Figure .

FIGURE 2

Nulling in horizontal main lobe of the antenna pattern



The following pictures Figure, Figure , Figure and Figure display the distribution of the separation distance as a function of the required isolation (dB) for the 4 (B, E, F and I) studied cases in the vicinity of the ground telemetry stations. Color ring-shape highlight required isolation range for –50 dB, –20 dB and 0 dB values for all figures. Cross border curve is represented in yellow as well as distances scale (50 km) to give an overall view on the required separation distance from the cross border.

FIGURE 3

Iso additional required pathloss to protect case B telemetry station

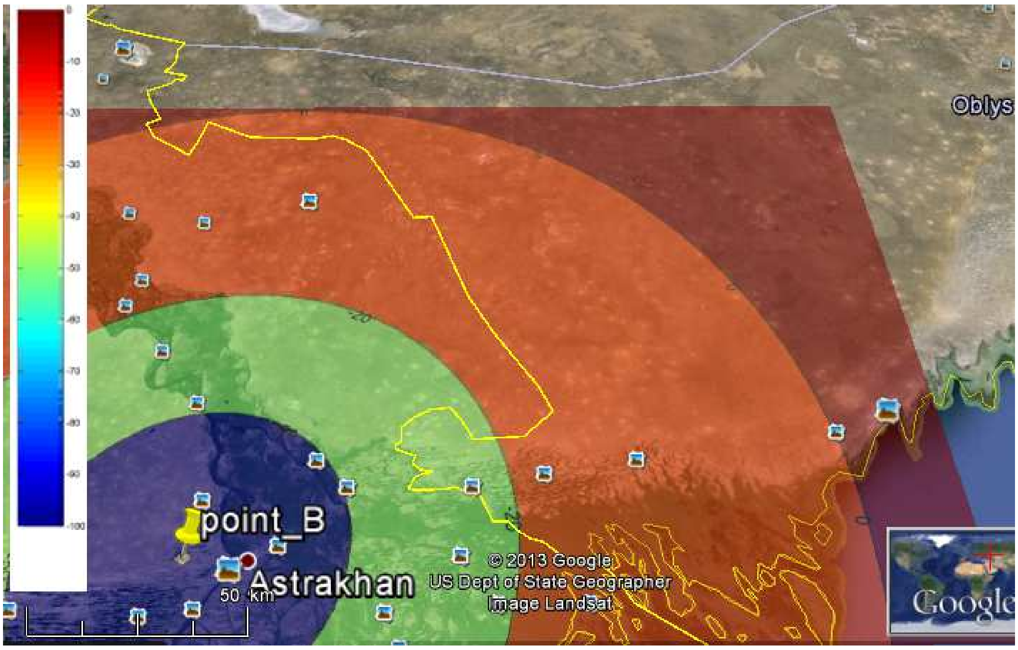


FIGURE 4

Iso additional required pathloss to protect case E telemetry station (Poland cross-border)

FIGURE5

Iso additional required pathloss to protect case E telemetry station (Lituania cross-border)

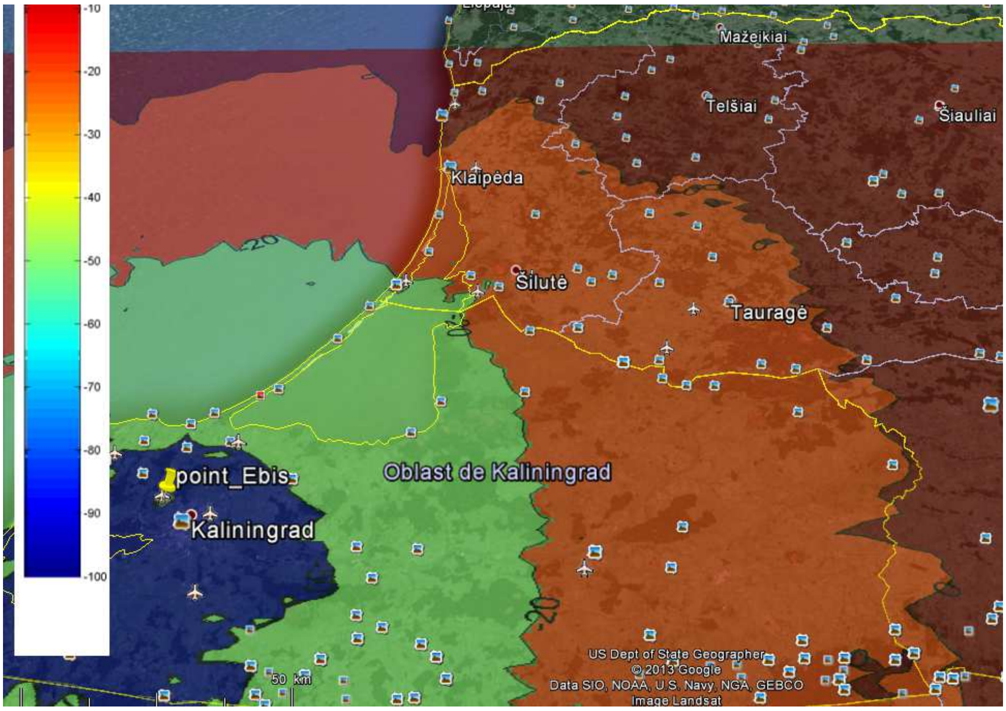
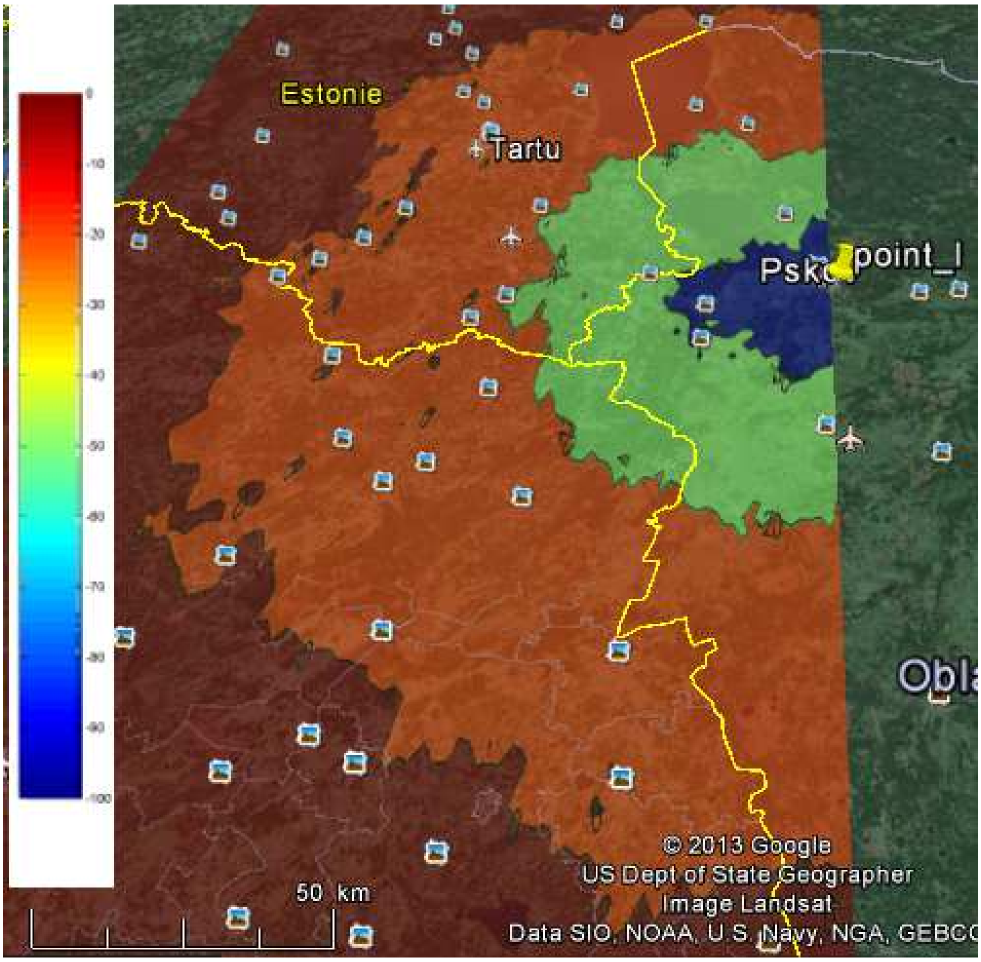


FIGURE 6

Iso additional required pathloss to protect case F telemetry station

FIGURE 7

Iso additional required pathloss to protect case I telemetry station (Estonia & Latvia)



The results of the sharing studies when using mitigation techniques are summarized in the following Table 5:

TABLE 5

Separation distance from the cross border with disabling sector

Case	Required additional isolation (dB)	Required addition isolation after disabling antenna sector or antenna pattern nulling (dB)	Separation distance from the cross border after mitigation techniques (km)
B	39	19	23
E	68 (Poland) 23 (Lithuania)	48 (Poland) 3 (Lithuania)	30 (Poland) 7 (Lithuania)
F	53.4	33.4	53
I	51 (Estonia) 37 (Latvia)	31 (Estonia) 17 (Latvia)	28 (Estonia) 17 (Latvia)

Secondary conclusion: When using mitigation techniques:

– 9/14 sites would require separation distances lower than 7km from the cross-border;

– 4/14 sites would require some tens km separation distance from the cross-border.

These separation distances from the cross-border (when using mitigation tehniques) can be converted in separation distances between SDL base station transmitter and Telemetry ground station receiver as depicted in the table below:

Case	Separation distance from the cross border (km)	Separation distance between IMT BS and Telemetry ground receiver (km)
B	23	77
D	0	181
E	30 (Poland) 7 (Lithuania)	75 (Poland) 77 (Lithuania)
F	53	81
G	7	99
H	1.5	106.5
I	28 (Estonia) 17 (Latvia)	65 (Estonia) 67 (Latvia)

This shows that high separation distances between the interferer and the receiver (181 km, 106.5 km) does not necessarily imply more stringent constraints on the IMT BS deployment: in these cases, with mitigation techniques usage, the protection only requires few (1.5km) or no separation distances from the cross-border because of the distant location of the ground telemetry receiver from the cross-border.

(Note that the missing K case with Finland is due to the lack of STRM data and does not prevent from forecasting that the expected separation distance should not overtake the maximum reached in the other cases (53 km)).

Furthermore, it has to be noted that additional mitigation techniques applied to the ground telemetry receiver such as site shielding (0-20dB) may reduce the separation distances output in the previous table, provided:

– that operation on aircraft, missiles are not expected to be launched in the vicinity of the cross-border;
– that administrations operating telemetry have to respect the principle of equitable access to spectrum as embedded in the preamble (0.6) of the RR (and which is explicitly described in Resolution **2 (rev. WRC-03)** in the case of satellite systems).

5 Conclusion

This document analyzed the impact of the IMT BS to the ground aeronautical telemetry stations that are notified in the BR IFIC when they share the same band within 1 427-1 492 MHz. It is shown that:

– 42% of the notified ground telemetry stations do not require additional protection to operate properly without suffering harmful interference from IMT BS;
– The 58% remaining ground telemetry stations may require mitigation techniques (sector disabling, antenna pattern nulling, down tilting…) applied to the IMT BS to reduce the geographical distance, which would lead to tens km separation distance from the cross-border. These separation distances could be more reduced when performing mitigation techniques to the ground telemetry stations.

From these comments, France is of the view that Macro BSs could be deployed based on bilateral coordination, taking into account equitable access principle. France also considers that these results could be reflected in the draft CPM text for WRC-15 agenda item 1.1.