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Working Group Spectrum

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DG 7 B- CPM ISSUES

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WORKING DOCUMENT TOWARDS DRAFT

5

CPM TEXT CHAPTER 2.9

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7 **2.9 Agenda item 1.33 - review and revise technical, operational and regulatory provisions,**
8 **including provisional limits in relation to the operation of High Altitude Platform**
9 **Stations within IMT-2000 in the bands S5.388A**

10 "to review and revise technical, operational and regulatory provisions, including provisional limits
11 in relation to the operation of High Altitude Platform Stations within IMT-2000 in the bands
12 S5.388A, in response to Resolution 221 (WRC-2000)".

13 Resolution 221 of WRC-2000 - as well as covering the provisional pfd limits, this Res. also invites
14 ITU-R to conduct further studies, including to "develop appropriate regulatory and technical
15 provisions to allow the coordination with neighbouring administrations".

16 **2.9.1 Introduction**

17 Provisions for operation of HAPS were originally made at WRC-97, for HAPS providing FS
18 operations in the 47.2-47.5 GHz and 47.9-48.2 GHz bands (S5.552A). A definition of HAPS was
19 also added to S1.66A. The use of HAPS as base stations to provide terrestrial IMT-2000 was
20 considered at WRC-2000, resulting in provisions to facilitate this being added to the Radio
21 Regulations (S5.388A). Resolution 221 from WRC-2000 includes provisional co-channel and
22 out-of-band power flux-density limits for HAPS operation, for the protection of other stations either
23 sharing the same band or operating in adjacent bands.

24 The main purpose of this agenda item is to confirm the provisional power flux-density limits for
25 HAPS operation in the IMT-2000 spectrum at 2 GHz that were determined at WRC-2000. The
26 provisional pfd limits adopted by WRC-2000 were based on the original version of the IMT-HAPS
27 Recommendation developed within Task Group 8/1.

28 WRC-03 agenda item 1.33 on HAPS operation within IMT-2000 refers to Resolution 221 of
29 WRC-2000, which, as well as asking for additional technical, operational and regulatory studies to
30 be conducted in order to review and, if necessary, revise the pfd limits, also asks for consideration
31 of appropriate regulatory and technical provisions to allow bilateral coordination of HAPS in an
32 IMT-2000 system with affected neighbouring administrations.

1 **2.9.2 Summary of technical and operational studies, including a list of relevant ITU-R**
2 **Recommendations**

3 **2.9.2.1 Protection of other IMT-2000 stations from co-channel interference from HAPS**
4 **operating as an IMT-2000 base station**

5 No studies have been undertaken until present.

6 **2.9.2.2 Review and, if necessary, revision of the provisional pfd limits in Resolution 221**
7 ***resolves 1a)***

8 Sharing studies have been carried out regarding the impact of the provisional pfd levels in
9 *resolves 1 a)* of Resolution 221 on the operation of 2G PCS and on the operation of MCS/MDS.

10 The studies have shown that the provisional pfd limits in Resolution 221 do not adequately meet
11 system design allowances for interference for these systems in particular and should therefore be
12 revised. Antenna discrimination at elevation angles should, however, be taken into consideration
13 when defining such revision.

14 **2.9.2.3 Protection of fixed service stations from co-channel interference from HAPS operating**
15 **as an IMT-2000 base station**

16 No input has been received to date.

17 **2.9.2.4 Protection of fixed stations in adjacent bands from HAPS operating as an IMT-2000**
18 **base station**

19 No input has been received to date.

20 **2.9.2.5 Other Relevant Studies**

21 - Sharing Considerations between High Altitude Platform Stations (HAPS) providing
22 IMT-2000 and other non-IMT 2000 systems operating in the same bands or adjacent bands

23 One study has been undertaken relating to issues arising from spectrum sharing between IMT-2000
24 services and other terrestrial services, which either operate within or adjacent to the IMT-designated
25 bands and which take into account existing and possible future uses (Sharing Considerations
26 between High Altitude Platform Stations (HAPS) providing IMT-2000 and other non-IMT 2000
27 systems operating in the same bands or adjacent bands). Such study aims in particular to respond to
28 the request, as detailed in Resolution 221, to address sharing and coordination between HAPS and
29 particular existing terrestrial systems such as PCS and MMDS.

30 **2.9.2.6 List of Relevant Recommendations**

31 1) Rec. ITU-R.1456, "Minimum performance characteristics (HAPS) and operational
32 conditions for High Altitude Platform Stations providing IMT-2000 in the bands
33 1 885-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz in Regions 1 and 3 and
34 1 885-1 980 MHz and 2 110-2 160 MHz in Region 2".

35 2) Rec. ITU-R F. 758 relating to the protection values for fixed stations

36 **2.9.3 Analysis of the results of studies**

37 The study regarding sharing considerations between High Altitude Platform Stations (HAPS)
38 providing IMT-2000 and other non-IMT 2000 systems operating in the same bands or adjacent
39 bands responds to the need to analyse and proposes changes to provisional pfd limits as specified in
40 Resolution 221 to protect some stations operating in these bands in the fixed and mobile services.

1 This subject has been extensively studied for over five years and Rec. ITU-R.1456, "Minimum
2 performance characteristics (HAPS) and operational conditions for High Altitude Platform Stations
3 providing IMT-2000 in the bands 1 885-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz in
4 Regions 1 and 3 and 1 885-1 980 MHz and 2 110-2 160 MHz in Region 2" was based on the results
5 of such studies. Since the last Conference, only one further study has been completed which
6 suggests that for a particular service, namely PCS and MMDS, the provisional pfd limits may not
7 adequately meet system design allowances for interference for 2GPCS. The studies suggest that
8 only for this particular system, the present limits exceed the interference allowance limits for 2G
9 PCS Mobile-to-base link in a co-channel environment and propose that the provisional co-channel
10 pfd limits in resolves 1 a) of Res. 221 be revised.

11 **2.9.4 Methods to satisfy the agenda item and their advantages and disadvantages.**
12 **Confirmation of the provisional pfd limits or revised limits.**

13 It is proposed that in order to adequately protect all terrestrial services within IMT-2000 in
14 neighbouring countries from co-channel interference, a HAPS operating as a base station to provide
15 IMT-2000 shall not exceed the following co-channel power flux-density (pfd) at the Earth's surface
16 outside an administration's borders unless agreed otherwise by the administration of the affected
17 neighbouring country:

- 18 $-126.7 \text{ dBW/m}^2 / \text{MHz}$ for angles of arrival (θ) less than 7° above the horizontal plane;
19 $-126.7 + 0.65 (\theta - 7) \text{ dBW/m}^2 / \text{MHz}$ for angles of arrival between 7° and 15° above the
20 horizontal plane; and
21 $-121.5 \text{ dBW/m}^2 / \text{MHz}$ for angles of arrival between 15° and 90° above the horizontal
22 plane.¹

23 It should also be noted that any revisions should take into consideration that the pfd's for sensitive
24 uplinks need not be the same as those for the less sensitive downlinks. Any revision to the
25 Resolution should accommodate such a difference. This could be through a note to the resolves
26 which would state that the provisional co-channel power-flux densities (pfd's) not to be exceeded set
27 out in the specific Resolves, represent the worst case levels to protect the most sensitive types of
28 terrestrial services implementations. Implementations such as Mobile services operated in the
29 down-link direction (base station to mobile) have a significantly greater tolerance to external
30 interference and in such cases the pfd's in Resolves 1 can be relaxed by [20] B.

31 **2.9.5 Regulatory and procedural considerations**

32 A MOD to Resolution 221 is needed which defines a notification process between neighbouring
33 administrations if the PFD levels are to be exceeded. This Resolution could refer to an ITU-R
34 Recommendation that would define the technical considerations to be addressed during this
35 consultation. See attachment 1 for an example draft MOD to Resolution 221 and attachment 2 for
36 an example

ATTACHMENT 1

Example of draft MODs to Resolution 221 (WRC-2000)

**Use of high altitude platform stations providing IMT-2000 in the bands
1 885-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz in Regions 1
and 3 and 1 885-1 980 MHz and 2 110-2 160 MHz in Region 2**

The World Radiocommunication Conference (Istanbul, 2000),

considering

- a) that the bands 1 885-2 025 MHz and 2 110-2 200 MHz are identified in No. **S5.388** as intended for use on a worldwide basis for IMT-2000, including the bands 1 980-2 010 MHz and 2 170-2 200 MHz for the satellite component of IMT-2000;
- b) that a high altitude platform station (HAPS) is defined in No. **S1.66A** as "a station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth";
- c) that HAPS may offer a new means of providing IMT-2000 services with minimal network infrastructure as they are capable of providing service to a large footprint together with a dense coverage;
- d) that the use of HAPS as base stations within the terrestrial component of IMT-2000 is optional for administrations, and that such use should not have any priority over other terrestrial IMT-2000 use;
- e) that in accordance with No. **S5.388** and Resolution **212 (Rev.WRC-97)**, administrations may use the bands identified for IMT-2000, including the bands referred to in this resolution, for stations of other primary services to which they are allocated;
- f) that these bands are allocated to the fixed and mobile services on a co-primary basis;
- g) that in accordance with No. **S5.388A**, HAPS may be used as base stations within the terrestrial component of IMT-2000 in the bands 1 885-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz in Regions 1 and 3 and 1 885-1 980 MHz and 2 110-2 160 MHz in Region 2; the use by IMT-2000 applications using HAPS as base stations does not preclude the use of these bands by any station in the services to which they are allocated and does not establish priority in the Radio Regulations;
- h) that ITU-R has studied sharing and coordination between HAPS and other stations within IMT-2000, has considered compatibility of HAPS within IMT-2000 with some services having allocations in the adjacent bands, and has established Recommendation ITU-R M.1456,

resolves

1 that for the purpose of protecting stations operating in neighbouring countries from
co-channel interference, a HAPS operating as a base station to provide IMT-2000 shall not exceed a
provisional co-channel power flux-density (pfd) of $-121.5 \text{ dB(W/(m}^2 \cdot \text{MHz))}$ at the Earth's surface
outside an administration's borders unless agreed otherwise by the consulted administration of the
affected neighbouring country;

1 2 that a HAPS operating as a base station to provide IMT-2000, in order to protect fixed
2 stations from interference, shall not exceed the following provisional values of out-of-band pfd at
3 the Earth's surface in the bands 2 025-2 110 MHz:

- 4 - -165 dB(W/(m² · MHz)) for angles of arrival (θ) less than 5° the horizontal plane;
- 5 - -165 + 1.75 ($\theta-5$) dB(W/(m² · MHz)) for angles of arrival between 5° and 25° above the
6 horizontal plane; and
- 7 - -130 dB(W/(m² · MHz)) for angles of arrival between 25° and 90° above the horizontal
8 plane;

9 3 that the consultation with neighbouring administrations, as mentioned in *resolves 1*, be
10 conducted taking into account ITU-R Rec. [(USWP8F/99) (HAPS_CON)];

11 34 that, as of the end of WRC-03, such a HAPS shall operate only in accordance with such
12 limits as are confirmed or, if appropriate, revised by WRC-03, irrespective of its date of bringing
13 into use;

14 45 that administrations wishing to implement HAPS within a terrestrial IMT-2000 system
15 shall comply with the following:

16 a) for the purpose of protecting certain stations operating within IMT-2000 in neighbouring
17 countries from co-channel interference, administrations using HAPS as base stations within
18 IMT-2000 shall use antennas that comply with the following antenna pattern:

$$\begin{aligned}
 19 \quad G(\psi) &= G_m - 3(\psi/\psi_b)^2 && \text{dBi} && \text{for } 0^\circ \leq \psi \leq \psi_1 \\
 20 \quad G(\psi) &= G_m + L_N && \text{dBi} && \text{for } \psi_1 < \psi \leq \psi_2 \\
 21 \quad G(\psi) &= X - 60 \log(\psi) && \text{dBi} && \text{for } \psi_2 < \psi \leq \psi_3 \\
 22 \quad G(\psi) &= L_F && \text{dBi} && \text{for } \psi_3 < \psi < 90^\circ
 \end{aligned}$$

23 where:

24 $G(\psi)$: gain at the angle ψ from the main beam direction (dBi)

25 G_m : maximum gain in the main lobe (dBi)

26 ψ_b : one-half of the 3 dB beamwidth in the plane considered (3 dB below G_m)
27 (degrees)

28 L_N : near side-lobe level in dB relative to the peak gain required by the system design,
29 and has a maximum value of -25 dB

30 L_F : far side-lobe level, $G_m - 73$ dBi

31 $\psi_1 = \psi_b \sqrt{(-L_N/3)}$ degrees

32 $\psi_2 = 3.745 \psi_b$ degrees

33 $X = G_m + L_N + 60 \log \psi_2$ dBi

34 $\psi_3 = 10^{((X-L_F)/60)}$ degrees

35 The 3 dB beamwidth ($2\psi_b$) is again estimated by:

$$36 \quad (\psi_b)^2 = 7.442 / (10^{(0.1G_m)}) \text{ degrees}$$

37 where G_m is the peak aperture gain (dBi);

38 b) for the purpose of protecting mobile earth stations within the satellite component of
39 IMT-2000 from interference, a HAPS operating as a base station to provide IMT-2000,
40 shall not exceed an out-of-band pfd of -165 dB(W/(m² · 4 kHz)) at the Earth's surface in
41 the bands 2 160-2 200 MHz in Region 2 and 2 170-2 200 MHz in Regions 1 and 3;

1 ~~56~~ that administrations wishing to implement HAPS within a terrestrial IMT-2000 system
2 shall, prior to their bringing into use, take into account in their bilateral consultation with affected
3 neighbouring administrations the operation and growth of existing and planned systems in the fixed
4 and mobile services having allocations on a primary basis;

5 ~~67~~ that, for the purpose of protecting fixed service stations operating in neighbouring countries
6 from co-channel interference, administrations wishing to implement HAPS within a terrestrial
7 IMT-2000 system shall take full account of the relevant ITU-R Recommendations relating to
8 protection values for fixed stations (see Recommendation ITU-R F.758).

9

ATTACHMENT 2

WORKING DOCUMENT TOWARDS A PRELIMINARY
DRAFT NEW RECOMMENDATION

**Consultation procedure between high altitude platform stations implementing
IMT-2000 services and other fixed and mobile services**

The ITU-R Radiocommunication Assembly,

considering

- a) that Resolution 221 (WRC-2000) invites ITU-R to develop appropriate regulatory and technical provisions to allow the coordination between a terrestrial IMT-2000 system implemented using high altitude platform stations and other existing or planned fixed and mobile services;
- b) that *coordination area* and *coordination distance* are defined in RR S1.171 and RR S1.173 for coordination between earth stations and terrestrial stations, but that the same concept may be extended to consultation between a HAPS platform and a terrestrial station: i.e. the area or distance beyond which the level of permissible interference will not be exceeded and coordination is therefore not required;
- c) that RR S1.66A defines a high altitude platform station as a station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth; thus a station may be subject to small changes in location, height and tilt;
- d) that Recommendation ITU-R M.1456 describes the minimum performance characteristics and operational conditions for high altitude platform stations providing IMT-2000 services and that this Recommendation indicates that HAPS deploys a multibeam antenna capable of projecting numerous spot beams;
- e) that, since the direction of propagation between a HAPS and the ground is obliquely through the troposphere, ducting is not expected; also, since the frequency is near to 2 GHz, scatter from hydrometeors is not expected, so that calculations may be based on free-space propagation,

recommends

1 that the coordination distance for a transmitting high altitude platform station is the distance
2 from the nominal nadir of the HAPS at which the spectral power flux-density falls to a level of
3 $-121.5 \text{ dB(W/(m}^2/1 \cdot \text{MHz))}$;^{*}

2 that the calculation procedure should be based on:

- the antenna gain of the outermost beam of the multibeam array at that azimuth, determined from the relationship given in Recommendation ITU-R M.1456 *recommends 2*, taking into account the maximum expected departure of the HAPS from the nominal location and height, and the maximum tilt from horizontal.
- the power delivered to that antenna beam;
- free-space propagation conditions.

* This value may need to be revised in order to be consistent with the value in resolves 1.1 of Res. 221 (WRC-2000).