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| CPG-7 |
| Hilversum, The Netherlands, 27th - 30th November 2018 |
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| Subject:  | Draft CEPT Brief on WRC-19 Agenda Item 1.14 |
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| Summary:  |
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| Proposal: |
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DRAFT CEPT BRIEF ON AGENDA ITEM 1.14

1.14 to consider, on the basis of ITU‑R studies in accordance with Resolution 160 (WRC-15), appropriate regulatory actions for high-altitude platform stations (HAPS), within existing fixed-service allocations

# ISSUE

Resolution 160 (WRC-15) resolves to invite ITU-R:

1. study additional spectrum needs for gateway and fixed terminal links for HAPS to provide broadband connectivity in the fixed service taking into account:

the existing identifications and deployments of HAPS systems;

the deployment scenarios envisioned for HAPS broadband systems and related requirements such as in remote areas;

the technical and operational characteristics of HAPS systems, including the evolution of HAPS through advances in technology and spectrally-efficient techniques, and their deployment;

1. study the suitability of using the existing identifications in recognizing c), on a global or regional level, taking into account the regulatory provisions, such as geographical and technical restrictions associated with existing HAPS identifications based on the study performed in resolves to invite ITU-R 1;
2. study appropriate modifications to the existing footnotes and associated resolutions in the identifications in recognizing c) in order to facilitate the use of HAPS links on a global or regional level, limited to the currently identified frequency bands and, where the use of an identification is not technically feasible for HAPS use, consider the possible removal of the unsuitable identification;
3. to study, in order to meet any spectrum needs which could not be satisfied under resolves to invite ITU-R 2 and 3, for the use of gateway and fixed terminal links for HAPS, the following frequency bands already allocated to the fixed service on a primary basis, not subject to Appendices 30, 30A, and 30B in any region:

on a global level: 38-39.5 GHz, and

on a regional level: in Region 2, 21.4-22 GHz and 24.25-27.5 GHz,

 further resolves

1. that the studies referred to in resolves to invite ITU-R 3 and 4 include sharing and compatibility studies to ensure protection of existing services allocated in the frequency ranges identified and, as appropriate, adjacent band studies, taking into account studies already performed in ITU-R.
2. that modifications studied under resolves to invite ITU-R 3 shall not consider the use of HAPS links in the frequency bands subject to Appendix 30B;
3. to develop ITU-R Recommendations and Reports, as appropriate, on the basis of the studies called for in resolves to invite ITU-R 1, 2, 3, and 4 above,

recognizing

a) that existing services and their applications shall be protected from HAPS applications, and no undue constraints shall be imposed on the future development of existing services by HAPS;

# Preliminary CEPT position

* CEPT supports, while ensuring protection of existing services and their future development including other applications of the fixed service (in accordance with Resolution 160 (WRC-15)) and subject to the conclusions of the ongoing sharing and co-existence studies for the bands mentioned below and, as appropriate, in the adjacent bands:

Worldwide designations for transmissions from high altitude platform stations (in the downlink direction) in the bands 6 440- 6 520 MHz, 27.9-28.2 GHz.

Worldwide designations for transmissions to and from high altitude platform stations (in the uplink and downlink directions) in the bands 31-31.3 GHz and 38-39.5 GHz

* For the bands 6 440-6 520 MHz, 27.9-28.2 GHz, 31- 31.3 GHz, 38-39.5 GHz, 47.2-47.5 GHz and 47.9-48.2 GHz, CEPT is supporting new footnotes and associated resolutions and/or appropriate modifications to the existing footnotes and associated resolutions.
* CEPT is of the view that any consideration of the frequency bands 21.4-22 GHz and 24.25-27.5 GHz in Region 2 under this Agenda item shall by accompanied by appropriate protection of: ISS in the band 24.45-24.75 GHz, ISS in the band 25.25-27.5 GHz, EESS (passive) in the bands 21.2-21.4 GHz, 22.21-22.5 GHz and 23.6-24 GHz, EESS and SRS (space-to-Earth) in the band 25.5-27 GHz and FSS in the bands 24.75-25.25 GHz and 27-27.5 GHz. This includes the appropriate protection of the mobile service in the band 24.25-27.50 GHz as results of consideration under WRC-19 agenda item 1.13.
* CEPT is of the view that any consideration of the frequency band 24.25-27.5 GHz in Region 2 under this Agenda item should not limit the possibility to identify the band for IMT on a global level under Agenda item 1.13.

# Background

As noted in the outcome of meeting of CPM19-1 (ITU administrative circular [CA/226](https://www.itu.int/dms_pub/itu-r/md/00/ca/cir/R00-CA-CIR-0226%21%21MSW-E.docx)), the studies under WRC-19 Agenda item 1.14 should take into account that the band 38.0-39.5 GHz is also being studied under WRC-19 Agenda items 1.6 and 1.13 and the band 24.25-27.5 GHz is under study under AI1.13.

Recent improvements in aerial platforms, lithium batteries, lightweight composite materials, solar technology, and spectral efficiency are creating the potential for realizable, large-scale HAPS systems. These technological innovations and the growing need for greater broadband connectivity have led to a call for review of the suitability of existing identifications, on a global or regional level, and current regulatory environment for HAPS. As the ITU-R has recognized, stations operating in the stratosphere are high enough to provide services to a large footprint but also low enough to provide low latency services and coverage in more densely populated areas.

Expanding broadband access (both coverage and capacity) is the foremost challenge for telecommunications policymakers throughout the world. Broadband has become the centre of our society and the key ticket to, and catalyst for, opportunity, education, health, growth, and prosperity. Therefore, it is important to ensure all citizens have access to broadband services. With sufficient capacity, HAPS can provide broadband connectivity over a large geographical region with throughput also suitable for dense user coverage.

Recent test deployments of stations delivering broadband from approximately 20 km above ground have demonstrated the potential of such stations for providing connectivity to underserved communities with minimal ground-level infrastructure and maintenance. HAPS can therefore be effective tools, among others, to help close the digital divide in remote communities, particularly those with challenging terrain or climate.

Examples of proposed HAPS applications are given in section 3.1.

In accordance with Resolution 160 (WRC-15), WP5C is developing a PDN Recommendation ITU-R F.[BROADBAND HAPS CHARACTERISTICS] (Annex 14 to doc 5C/531) that provides deployment and technical characteristics for the FS using HAPS stations in the frequency bands: 6 440-6 520 MHz, 6 560-6 640 MHz, 21.4-22.0 GHz, 24.25-27.5 GHz, 27.9-28.2 GHz, 31.0-31.3 GHz, 38.0‑39.5 GHz, 47.2-47.5 GHz and 47.9-48.2 GHz. It provides information on broadband HAPS links for use in sharing and compatibility studies in the frequency bands listed above, and in adjacent bands.

WP 5C has finalised the draft CPM text and supporting studies are expected to be finalised at a future WP 5C meeting. The draft CPM text contains following options/methods for each of the bands under scope of this agenda Item. There are a number different options including technical measures which may be used to address sharing and compatibility aspects with other services and applications within these bands and, as appropriate, in adjacent bands.

Method A – No change

The existing provisions in the Radio Regulation remain unchanged in the corresponding frequency band.

Method B – Designation of bands, in accordance with Resolution 160 (WRC-15) with options

Method B1 – Revision of the regulatory provisions for HAPS in the fixed service (FS) with a primary status in bands already designated for HAPS

This may include, e.g. global or regional designation for HAPS, limitations regarding link directions, and inclusion of the technical conditions of operation of HAPS systems for the protection of other services. This could be achieved by new or revised footnotes to the Table of Frequency Allocations, and new or revised associated Resolutions.

Method B2 – Add new designation(s) for HAPS in bands already allocated to the FS with a primary status

This may include, e.g. global or regional designation for HAPS, limitations regarding link directions, and inclusion of the technical conditions of operation of HAPS systems for the protection of other services. This could be achieved by new or revised footnotes to the Table of Frequency Allocations, and new or revised associated Resolutions.

Method B3 – Add a primary allocation to the FS and a new designation for HAPS in the band 24.25-25.25 GHz (Region 2) not already allocated to the FS

This may include, primary allocation for FS in Region 2 and designation for HAPS in that Region, together with conditions e.g. limitations regarding link directions, and inclusion of the technical conditions of operation of HAPS systems for the protection of other services. This could be achieved by new or revised footnotes to the Table of Frequency Allocations, and new or revised associated Resolutions.

Method C – Suppress the existing HAPS designation, pursuant to resolves 3 of Resolution 160 (WRC-15).

Table 1: Summary of methods to satisfy the agenda item and associated frequency bands

|  |  |
| --- | --- |
| Bands | Methods and Options |
| Method A | Method B | Method C |
| 6 440- 6 520 MHz | √ | B1 | √ |
| 6 560- 6 640 MHz | √ | Not proposed | √ |
| 21.4-22 GHz (R2 only) | √ | B2 | N/A |
| 24.25-25.25 GHz (R2 only) | √ | B3 | N/A |
| 25.25-27.5 GHz (R2 only) | √ | B2 | N/A |
| 27.9-28.2 GHz | √ | B1 | √ |
| 31.0-31.3 GHz | √ | B1 | √ |
| 38-39.5 GHz | √ | B2 | N/A |
| 47.2-47.5 GHz / 47.9-48.2 GHz | √ | B1 | √ |

## BROADband HAPS applications

HAPS systems provide fixed service connections between the platform and FS ground stations. During the development of ITU-R studies under WRC-19 Agenda item 1.14, different HAPS applications were presented.

### Broadband HAPS for connectivity applications

The aim of HAPS is to provide internet access to users in remote and rural areas on a medium to long term basis. It can be direct–to-home fixed access (see section 3.3.1), or it can be a link to a fixed access point (see section 3.3.2). HAPS can also provide backhauling connectivity for networks.

### Broadband HAPS for specific applications

Those applications are providing for disaster relief missions as described in Report ITU-R M.2377-0 (Annex 7[[1]](#footnote-1)).

HAPS aims to provide for connectivity for PPDR, when terrestrial infrastructure is not available or insufficient in the area affected. HAPS will connect the site(s) with the backbone of the national PPDR network.

## Broadband HAPS deployment scenarios

During the development of ITU-R studies under WRC-19 Agenda item 1.14, two HAPS deployment scenarios were considered.

### Access for end users

HAPS are providing fixed access to end users.



Figure 1: Illustration of direct access scenario

### Backhauling

HAPS are providing backhaul to ground infrastructure/networks.

 

Figure 2: Illustration of backhauling scenario

## Broadband haps spectrum requirements

### Broadband HAPS spectrum requirements for direct fixed access

Studies within CEPT based on the capacity demand for different broadband HAPS system approaches, and incorporated in document 5C/531 Annex 12, have derived an overall reference capacity to be considered for determining the spectrum needs in the order of 30 Gbps per HAPS for the forward links. Based on assumptions in these studies, results show that the current HAPS identifications will not satisfy the throughput requirements expressed for both CPE and gateway links. Those studies are based on assumptions that could be impacted by sharing analyses with incumbent services.

Several system designs have been analysed within CEPT to provide 30 Gbps for the forward links and their spectrum needs are summarised in the following Table 2 (other systems proposed by administrations outside CEPT are also currently considered in Table 2 of the Preliminary Draft New Report ITU-R F.[HAPS-SPECTRUM NEEDS]; Annex 12 to Doc 5C/531).

Table 2: Spectrum needs for Broadband HAPS connectivity applications for systems proposed by CEPT

|  |  |  |
| --- | --- | --- |
|  | Forward | Return |
|  | GW => HAPS | HAPS => CPE | CPE => HAPS | HAPS => GW |
| MHz | 1114-1800 | 576-900 | 59-240 | 310-480 |

### Broadband HAPS spectrum requirements for specific applications

Studies within CEPT, incorporated in document 5C/531 Annex 12, show that 120 Mbps for the forward link as well as for the return link will be sufficient to cover the broadband HAPS specific applications needs except the needs for PPDR applications (e.g. high resolution video, images, etc.) for which an additional capacity of 100 Mbps is needed for the HAPS forward and return link.

This is based on the broadband PPDR capacity demand, which is addressed in Report ITU-R M.2377-0 (Annex 7[[2]](#footnote-2)).

The broadband HAPS for specific applications spectrum requirements has been analysed and is provided in the following Table 3.

Table 3: Spectrum requirements for broadband HAPS for specific applications

|  |  |  |
| --- | --- | --- |
|  | Forward | Return |
|  | GW => HAPS | HAPS => CPE | CPE => HAPS | HAPS => GW |
| MHz | 110 | 15 | 15 | 110 |

### Inter-HAPS links

No additional spectrum requirements are foreseen at this stage for inter-HAPS.

## Technical and regulatory studies in Existing designated bands for haps

### 6 440-6 520 MHz (HAPS to ground) and 6 560-6 640 MHz (ground to HAPS)

#### Current Radio Regulation in the band 6 640-6 520 MHz and 6 560-6 640 MHz

For the five countries listed in footnote 5.457[[3]](#footnote-3), the allocation to the fixed service in the bands 6 440-6 520 MHz (HAPS-to-ground direction) and 6 560-6 640 MHz (ground-to-HAPS direction) is identified for high-altitude platform stations (HAPS). Such use is limited to gateway links within the territory of these countries, and in accordance with Resolution 150 (Rev.WRC-12), defining operating conditions in order to protect incumbent services in these bands (e.g. antenna beam patterns, aggregate pfd criterion and a maximum EIRP value). HAPS gateway links shall not claim protection from existing services, and existing services may not be constrained in future development by HAPS gateway links.

The use of HAPS gateway links in these bands requires explicit agreement with other administrations whose territories are located within 1 000 kilometres from the border of an administration intending to use the HAPS gateway links.

The frequency bands 6 440-6 520 MHz and 6 560-6 640 MHz are worldwide allocated on a primary status to the fixed, the mobile and the fixed satellite (Earth-to-space) services. In Region 2 (except a limited list of countries), the band 5 925-6 700 MHz may be used for aeronautical mobile telemetry for flight testing by aircraft stations. Such use shall be in accordance with Resolution 416 (WRC-07) and shall not cause harmful interference to, nor claim protection from, the fixed-satellite and fixed services.

In the band 6 425-7 075 MHz, passive microwave sensor measurements are carried out over the oceans. In the band 7 075-7 250 MHz, passive microwave sensor measurements are carried out. Administrations should bear in mind the needs of the Earth exploration-satellite (passive) and space research (passive) services in their future planning of the bands 6 425-7 075 MHz and 7 075-7 250 MHz. For the purpose of protecting EESS passive operations over oceans from HAPS gateway uplinks, in accordance with Resolution 150 (WRC-12) HAPS gateway stations shall maintain a minimum distance of 100 kilometres for a single HAPS gateway station and 150 kilometres for several HAPS gateway stations from coast lines.

#### Sharing with Fixed Service (FS)

6440-6520 MHz band (Impact from HAPS platform transmission into FS receiver).

The analysis performed shows that the following pfd mask in dBW/m2/MHz, to be applied under clear sky conditions at the surface of the Earth, ensures the protection of the Fixed Service by meeting its long term protection criteria:

 for

 for

 for

 for

where El is the elevation angle in degrees (angles of arrival above the horizontal plane).

Note that the pfd level shown above is derived from a maximum interference level of
-149.5 dBW/MHz (i.e., I/N = -10 dB not to be exceeded for more than 20% of the time) for the FS long-term protection criteria. The FS parameters and deployment density are taken from Recommendations ITU-R F.758 and ITU-R F.2086, respectively. Gaseous atmospheric attenuation is not considered for this frequency range.

To verify that the pfd produced by HAPS platform does not exceed the proposed pfd mask, the following equation was used:

where:

EIRP is the maximum HAPS EIRP density level in dBW/MHz (dependent to the elevation angle)

d is the distance between the HAPS and the ground (elevation angle dependent)

6440-6520 MHz band (Impact from FS transmission into HAPS ground station receiver).

The antennas used for both HAPS ground terminals and FS stations are directional, therefore, the required separation distance between the two systems can be reduced by appropriate site-configuration. Protection between HAPS ground stations and conventional FS stations can be managed on a case-by-case basis by coordination amongst administrations or usual link/planning method and procedures used at national level for conventional FS stations.

6560-6640 MHz band

This band is not considered for the time being within CEPT.

#### Sharing with Mobile Service (MS)

6440-6520 MHz band (impact from HAPS platform transmission into MS receivers)

The analysis performed shows that the following pfd mask (in dBW/m²/MHz), to be applied under clear sky conditions at the surface of the Earth, ensures the protection of the Mobile Service receivers:

where El is the elevation angle in°(angles of arrival above the horizontal plane)

Note that gaseous atmospheric loss was not considered for this frequency range as it is negligible.

To verify that the pfd produced by HAPS platform does not exceed the proposed pfd mask, the following equation shall be used:

where:

EIRP is the maximum HAPS EIRP density level in dBW/MHz (dependent to the elevation angle)

d is the distance between the HAPS and the ground (Elevation angle dependent)

6440-6520 MHz band (impact from MS transmission into HAPS ground station receivers)

The study performed considered two different percentages of time, i.e., 20 % and 0.01 %, and used propagation model Recommendation ITU-R P.452. The study showed that for both cases, the impact of MS station emissions into HAPS ground station receivers is in order of 0-10 km depending on the probability considered compared to 0-43 km between the MS and conventional FS station for the same probabilities. In addition, the required separation distance can be further reduced by appropriate site-configuration, due to HAPS antenna directivity. Therefore, protection between HAPS ground stations and MS stations can be managed on a case-by-case basis by coordination amongst administrations at national level.

6560-6640 MHz band

This band is not considered for the time being within CEPT.

#### Sharing with Fixed-Satellite Service (FSS)

6440-6520 MHz band (impact from HAPS platform transmission into FSS space receivers)

The analysis performed shows that HAPS systems downlink emissions will not impact the FSS stations receivers if the maximum EIRP density per HAPS is lower than -17.8 dBW/MHz in any direction for off-nadir angle higher than 95°. The studies also show that it is possible to design a HAPS system compliant with the above proposed e.i.r.p. limit and protect FSS satellite with large margin.

6440-6520 MHz band (impact from FSS Earth station transmission into HAPS ground station receivers)

The study considered the potential emissions from FSS Earth stations received by the HAPS Gateway or CPE receiver. This analysis also compared the level of emissions at the HAPS receivers to those that would be received by a Fixed Service receiver.

The analysis performed shows that the required separation distance of HAPS Gateway or CPE receivers and FSS Earth stations is less than the required separation distance between an FSS Earth station and FS terminal.

6560-6640 MHz band

This band is not considered for the time being within CEPT.

#### Sharing with Earth exploration-satellite (passive) and space research (passive) services over the oceans

Currently the band 6 425-7 075 MHz is used by several passive microwave sensors. Some examples are: AMSR-2 (JAXA GCOM programme), MWI (NSOAS HY-2 programme) and WindSat (US Coriolis). In addition, the Copernicus Imaging Microwave Radiometry Mission (CIMR) is under consideration in Europe to provide enhanced continuity of AMSR-2 data for Copernicus services.

6440-6520 MHz band (HAPS-to-ground direction)

Two CEPT studies provide consistent results, showing that in order to protect EESS (passive) the EIRP of HAPS platforms would have to be limited to -34.9 dBW/200 MHz in any direction for off-nadir angle higher than 125°.

Such EIRP limit can be met when considering the actual parabolic antenna pattern as well as the additional attenuation provided by the HAPS structure and should only apply to operation of HAPS over the oceans or over the land at a distance lower than 29 km from an ocean coast lines (distance between the sub HAPS point and the ocean coast line).

6560-6640 MHz band

This band is not considered for the time being within CEPT.

#### Sharing with RAS stations performing observations in the 6 650-6 675.2 MHz frequency range and HAPS systems operating in the 6 440-6 520 MHz frequency ranges.

HAPS-to-ground

The band 6 650-6 675.2 MHz is not allocated to the RAS but is included in No 5.149 which urges administrations to take all practicable steps to protect radio astronomy.

The RAS station performing observations in the band 6 650-6 675.2 MHz can be protected from HAPS platforms downlink transmissions in the band 6 440-6 520 MHz provided that such HAPS platforms meet unwanted emission pfd values of -210 dBW/m²/50 kHz for spectral line observations in the 6 650-6 675.2 MHz band at the RAS station location. These pfd values shall be verified considering a percentage of time of 2% in the relevant propagation model. These pfd values are extrapolated from ITU-R RA.769, taking into account a RAS antenna gain of 30 dBi because of the probability of main beam coupling.

1. Studies in WP5C need to be updated in order to take into account RAS antenna gain of 30 dBi instead of 15 dBi

### 27.9-28.2 GHz (HAPS to ground) and 31-31.3 GHz (ground to HAPS and HAPS to ground)

#### Current Radio Regulation in the band 27.9-28.2 GHz and 31-31.3 GHz

HAPS has an identification at 27.9-28.2 GHz, which is allocated to the fixed, fixed satellite (Earth‑to-space) and mobile service on a primary basis. Additionally, No 5.540 makes a secondary allocation to the fixed satellite service (space-to-Earth) for beacon transmissions intended for up-link power control at 27.501-29.999 GHz. The HAPS identification in No 5.537A permits use within the territory of 23 countries in Regions 1 and 3. Such use is limited to operation in the HAPS-to-ground direction and requires HAPS systems to avoid causing harmful interference to, and precludes HAPS systems from claiming protection from, other fixed service systems or co-primary services.

The 31.0-31.3 GHz band is allocated to the fixed and mobile service on a primary basis, and the standard frequency and time signal satellite service and space research service on a secondary basis. Pursuant to RR No 5.543A, the same countries mentioned above are permitted to use this band for HAPS in the ground-to-HAPS direction. Such use may not cause harmful interference to, nor claim protection from, other types of fixed service systems or mobile service systems[[4]](#footnote-4). HAPS must also avoid harmful interference to the radio astronomy service and EESS (passive), which have primary allocations in the 31.3-31.8 GHz band. No 5.340 applies in 31.3-31.5 GHz for all Regions and in 31.5-31.8 GHz for Region 2. Resolution 145 (Rev.WRC-12) ensures protection of the adjacent radio astronomy service by placing a pfd limit on the HAPS ground station antenna, while adding mandatory coordination and agreement with considered neighbouring administrations. In order to ensure protection of EESS (passive), levels of unwanted power density applying to HAPS ground stations in the frequency band 31.3-31.8 GHz are given in No 5.543A.

#### Sharing with Fixed Service (FS) in the bands 28 GHz and 31 GHz

27.9-28.2 GHz band (Impact from HAPS platform transmission into FS receiver)

The analysis performed shows that the following pfd mask in dBW/m²/MHz, to be applied under clear sky conditions at the surface of the Earth, ensures the protection of the Fixed Service by meeting its long term protection criteria.

where El is the elevation angle in degrees (angles of arrival above the horizontal plane).

Note that the pfd level shown above is derived from a maximum interference level of
-146 dBW/MHz (i.e., I/N = -10 dB not to be exceeded more than 20% of the time) for the FS long-term protection criteria. The FS parameters and deployment density are taken from Recommendations ITU-R F.758 and ITU-R F.2086, respectively. The FS antenna pattern is based on ITU-R F.1245 and gaseous atmospheric attenuation is considered (Recommendation ITU-R SF.1395).

1. The above pfd limits for the 27.9 – 28.2 GHz is subject to the conclusion of the correspondent activity on 1.14.

This study made the assumption that to compensate for additional propagation impairments in the main beam of the HAPS due to rain, the pfd mask can be increased in the corresponding beam by a value equivalent to the level of rain fading but limited to a maximum of 20 dB.

1. The wording above is subject to the conclusion of the correspondent activity on 1.14.

To verify the compliance with the proposed pfd mask the following equation shall be used:

where:

EIRP: is the nominal HAPS platform EIRP spectral density in dBW/MHz (dependent to the elevation angle)

d: is the distance between the HAPS and the ground (elevation angle dependent).

The impact of the gas attenuation is not included in the verification formula since it is already taken into account in the pfd mask.

27.9-28.2 GHz band (Impact from FS transmission into HAPS ground station receiver)

The study shows that the antennas used for both HAPS ground terminals and FS stations are directional, therefore, the required separation distance between the two systems can be reduced by appropriate site-configuration. Protection between HAPS ground stations and conventional FS stations can be managed on a case-by-case basis by coordination amongst administrations or usual link/planning method and procedures used at national level for conventional FS stations.

31-31.3 GHz band (Impact from HAPS platform transmission into FS receiver)

The analysis performed shows that the following pfd mask in dBW/m²/MHz, to be applied under clear sky conditions at the surface of the Earth, ensures the protection of the Fixed Service by meeting its long term protection criteria.

where El is the elevation angle in ° (angles of arrival above the horizontal plane).

Note that the pfd level shown above is derived from a maximum interference level of
-148 dBW/MHz (i.e., I/N = -10 dB not to be exceeded more than 20% of the time) for the FS long‑term protection criteria. The FS parameters and deployment density are taken from Recommendations ITU-R F.758 and ITU-R F.2086, respectively. The FS antenna pattern is based on ITU-R F.1245 and gaseous atmospheric attenuation is considered (Recommendation ITU-R SF.1395).

This study made the assumption that to compensate for additional propagation impairments in the main beam of the HAPS due to rain, the pfd mask can be increased in the corresponding beam by a value equivalent to the level of rain fading but limited to a maximum of 20 dB.

1. The wording above is subject to the conclusion of the correspondent activity on 1.14.

To verify the compliance with the proposed pfd mask the following equation shall be used:

where:

EIRP: is the nominal HAPS platform EIRP spectral density in dBW/MHz (dependent to the elevation angle);

d: is the distance between the HAPS and the ground (elevation angle dependent).

The impact of the gas attenuation is not included in the verification formula since it is already taken into account in the pfd mask.

31-31.3 GHz band (Impact from FS transmission into HAPS ground station receiver)

The study shows that the antennas used for both HAPS ground terminals and FS stations are directional, therefore, the required separation distance between the two systems can be reduced by appropriate site-configuration. Protection between HAPS ground stations and conventional FS stations can be managed on a case-by-case basis by coordination amongst administrations or usual link/planning method and procedures used at national level for conventional FS stations.

31-31.3 GHz band (ground-to-HAPS direction)

Generally, it was shown that sharing between FS and HAPS gateway and CPE stations is feasible. The interference from HAPS GW/CPE could be managed between administrations on a bilateral basis as it is the case between FS to FS stations. Therefore, there may be no need of regulatory provisions in the Radio Regulations for this case.

#### Sharing with Mobile Service (MS) in the bands 28 GHz and 31 GHz

27.9-28.2 GHz band (HAPS-to-ground direction)

The analysis performed shows that the following pfd mask in dBW/m²/MHz, to be applied under clear sky conditions at the surface of the Earth, ensures the protection of the Mobile Service receivers:

where El is the elevation angle in ° (angles of arrival above the horizontal plane)

Note that for the pfd level above, polarisation and gaseous atmospheric (ITU-R SF.1395) losses are considered. In addition, body loss is considered for the user equipment pfd level calculation.

This study made the assumption that to compensate for additional propagation impairments in the main beam of the HAPS due to rain, the pfd mask can be increased in the corresponding beam by a value equivalent to the level of rain fading.

To verify the compliance with the propose pfd mask the following equation shall be used:

where:

EIRP: is the nominal HAPS platform EIRP spectral density in dBW/MHz (dependent to the elevation angle);

d: is the distance between the HAPS and the ground (elevation angle dependent).

31-31.3 GHz band (HAPS-to-ground direction)

No MS system deployment or characteristics have been reported in the band 31-31.3 GHz.

31-31.3 GHz band (ground-to-HAPS direction)

No MS system deployment or characteristics have been reported in the band 31-31.3 GHz.

#### Sharing with Fixed-Satellite Service (FSS) in the band 28 GHz

27.9-28.2 GHz band (impact from HAPS platform transmission into FSS space receivers)

Two studies considered the potential impact of HAPS platform emissions into the FSS GSO and NGSO space station receivers. These studies included assessment for satellite receiver I/N values of ‑12.2 dB. No assumption on the percentage of time associated to that interference level was needed.

The analysis performed shows that HAPS system downlink emissions will not impact the FSS receivers if the e.i.r.p. per HAPS platform transmitter is limited to -9.7 dBW/MHz in any direction for off-nadir angle higher than 95°.

27.9-28.2 GHz band (impact from FSS Earth station transmission into HAPS ground station receiver)

The study considered the potential impact of emissions from FSS Earth stations received by the HAPS ground station receiver. This analysis also compared the level of emissions at the HAPS receivers to those that would be received by a Fixed Service receiver.

The analysis performed shows that the required separation distance of HAPS Gateway or CPE receivers and FSS Earth stations is less than the required separation distance between an FSS Earth station and FS terminal. When assuming two specific interference scenarios with an I/N criterion of -6dB not to be exceeded more than either 20 % and 0.001% of time, results show that using the worst case antenna pointing and specific terrain assumptions, separation distances from 0.39 km to 34 km and from 0.41 km to 57.3 km (for the cases of 20% and 100%, respectively) would be required. The study showed that the separation distances can be significant in order to mitigate interference from the FSS Transmit Earth Stations into the HAPS Receive Gateways for a single entry.

1. ’these scenarios need to be updated taking into account a HAPS long term protection criterion of -10 dB not be exceeded more than 20% of the time, and a HAPS short term protection criterion of +10 dB not be exceeded more than 0.01% of the time as agreed at the last WP5C meeting.

#### Compatibility with EESS (passive) in the 31.3 – 31.8GHz

31-31.3 GHz band (HAPS-to-ground direction)

Four independent studies show that compatibility between EESS (passive) and HAPS platform downlinks is feasible provided that unwanted e.i.r.p. emission from the HAPS platform in the band 31.3-31.8 GHz is below the following values:

where: El is the elevation angle (°) at the platform height.

This e.i.r.p mask would cover all the transmissions from the HAPS platform (i.e. towards CPE and/or gateways) that could also have emissions in the direction of the EESS satellite. An apportionment of 5 dB of the EESS (passive) protection criterion was considered.

It was shown that at least one of the HAPS systems can meet such e.i.r.p. limit, based on the assumptions taken.

31-31.3 GHz band (ground-to-HAPS direction)

HAPS ground stations will require an out of band attenuation of the order of 60 dB. This attenuation can be easily achievable with the current technology by shaping the GW/CPE signal spectrum in the out of band domain, with an RF filtering and by having a frequency gap between the HAPS and the EESS band (e.g. by choosing the band 31-31.06 GHz provides 240 MHz guard band).

In order to ensure the protection of satellite passive services, the level of unwanted power density into any HAPS ground station antenna in the band 31.3-31.8 GHz shall be limited to −83 dB(W/200MHz) under clear-sky conditions and may be increased under rainy conditions to mitigate fading due to rain, provided that the effective impact on the passive satellite does not exceed the impact under clear-sky conditions. This is equivalent to the -106 dB(W/MHz) limit in resolves 3 of Resolution 150 on the level of unwanted power density into the HAPS ground station antenna in the band 31.3-31.8 GHz.

For HAPS systems operating in the uplink, studies need to demonstrate feasibility of compliance with the unwanted level given above (−83 dB(W/200MHz) for the protection of EESS (passive) .

#### Compatibility with RAS in 31.3- 31.8 GHz

31-31.3 GHz band (HAPS-to-ground direction)

A RAS station performing observations in the band 31.3-31.8 GHz can be protected from HAPS platforms downlink transmissions in the band 31-31.3 GHz provided that such HAPS platforms meet unwanted emission pfd values of -171 dBW/m²/500 MHz in the 31.3‑31.8 GHz band at the RAS station location. These pfd values shall be verified considering a percentage of time of 2% in the relevant propagation model as described in Recommendation ITU-R RA.769, taking into account a RAS antenna gain of 30 dBi because of the probability of main beam coupling.

1. Studies in WP5C need to be updated in order to take into account RAS antenna gain of 30 dBi instead of 15 dBi

31-31.3 GHz band (ground-to-HAPS direction)

A RAS station performing observations in the band 31.3-31.8 GHz can be protected from HAPS CPE and Gateways uplink transmissions in the band 31-31.3 GHz provided that those stations meet an unwanted emission pfd value of -141 dBW/m²/500 MHz in the 31.3‑31.8 GHz band at the RAS station location at a height of 50 m. This pfd value shall be verified considering a percentage of time of 2% in the relevant propagation model. The possibilities for placement of HAPS ground stations may be affected by their situation with respect to the RAS station and HAPS platform.

### 47.2-47.5 GHz and 47.9-48.2 GHz

#### Current Radio Regulation in the band 47.2-47.5 GHz and 47.9-48.2 GHz

HAPS has a worldwide identification at 47.2-47.5 GHz and 47.9-48.2 GHz, which are allocated to the fixed, satellite (Earth-to-space) and mobile services on a co-primary basis. The use of the bands 47.2-47.5 GHz and 47.9‑48.2 GHz is subject to the provisions of Resolution 122 (Rev.WRC-07), which establishes maximum transmit EIRP levels, antenna beam patterns and pfd levels for HAPS operations, including HAPS to ground and ground to HAPS sharing and compatibility conditions with respect to the FSS, FS, RAS.

HAPS to ground direction

The current provisions in Resolution 122 (Rev.WRC-07) are expected to remain the same.

Ground to HAPS direction

The current provisions in Resolution 122 (Rev.WRC-07) are expected to remain the same for all other incumbent services, apart from FSS as described below.

Current Radio Regulation to protect FSS is sufficient as of Resolution 122 (Rev.WRC-07) in clear sky condition.

The gateways station antenna pattern will comply with the antenna pattern as of Resolution 122 (Rev.WRC-07) resolves 3.

Under raining condition a rain margin of at least 20 dB has to be provisioned in recognizing d) and resolves 2 of ITU-R Resolution 122 for sharing with the FSS. Therefore, Resolution 122 (Rev.WRC-07) needs to be revised accordingly.

1. The wording above is subject to the conclusion of the correspondent activity on 1.14.

### Initial views on the suitability of using existing designated bands for HAPS

3 summarises current situation based on studies so far and does not reflect final conclusions for these bands. This table will be refined as sharing and compatibilities progress for these bands.

 Table 3: Summary of current situation based on studies

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency band | Suitable | Region | Need new/amendment Footnotes  | Need new/amendment Resolution  |
| HAPS->Ground |  |
| 6 440-6 520 MHz | Yes | Global | Yes | Yes |
| 6 560-6 640 MHz | This band is not considered for the time being within CEPT. |
| 27.9-28.3 GHz | Yes | Global | Yes | Yes |
| 31-31.3 GHz | Yes | Global | Yes | Yes |
| 47.2-47.5 GHz  | Yes | Global | No | No |
| 47.9-48.2 GHz | Yes | Global | No | No |
| Ground->HAPS |  |
| 6 440-6 520 MHz |  This band is not considered for the time being within CEPT. |
| 6 560-6 640 MHz |  Yes under existing provisions |
| 27.9-28.3 GHz |  This band is not considered for the time being within CEPT. |
| 31-31.3 GHz | Yes | Global | Yes | Yes |
| 47.2-47.5 GHz  | Yes | Global | Yes | Yes |
| 47.9-48.2 GHz | Yes | Global | Yes | Yes |

1. the suitability of a band is subject to the associated regulatory provisions indicated in the draft ECP

## technical and regulatory Studies in possible new bands for Worldwide designations for haps

### Worldwide (38-39.5 GHz)

#### Compatibility with SRS (space-to-Earth) Earth stations in 37-38 GHz

Ground to HAPS and HAPS to ground

The studies show that the protection level of -217 dB(W/Hz) at the input of the SRS receiver with 0.001% exceedance due to atmospheric and precipitation effects as referred in the relevant ITU-R Recommendations, may be achieved through a combination of separation distance and attenuation of unwanted emissions for HAPS stations operating in the band 38-39.5 GHz.

#### Sharing with Fixed Service (FS)

Ground to HAPS (impact from HAPS ground station transmission into FS station receivers)

Several studies show that the antennas used for both HAPS ground terminals and FS stations are directional, therefore, the required separation distance between the two systems can be reduced by appropriate site-configuration. Protection between HAPS ground stations and conventional FS stations can be managed on a case-by-case basis by coordination amongst administrations or usual link/planning method and procedures used at national level for conventional FS stations.

Ground to HAPS (impact from FS station transmission into HAPS platform station receivers)

The study shows that the HAPS platform gateway beam station short term protection criteria (I/N = +10 dB) is never exceeded. The long term (I/N = -10 dB) is exceeded for less than 1 over 900 deployments scenarios in the case of HAPS gateway beam and less than 1 over 2000 deployments scenarios in case of HAPS CPE beam.

HAPS to ground (impact from HAPS platform station transmission into FS station receivers)

The analysis performed shows that the following pfd mask in dBW/m²/MHz, to be applied under clear sky conditions at the surface of the Earth, ensures the protection of the fixed Service by meeting its long term protection criteria:

where El is the elevation angle in ° (angles of arrival above the horizontal plane)

Note that the pfd level shown above is derived from on a maximum interference level of
-147 dBW/MHz (i.e., I/N = -10 dB not to be exceeded more than 20% of the time) for the FS long‑term protection criteria. The FS parameters and deployment density are taken from Recommendations ITU-R F.758 and ITU-R F.2086, respectively. Note that gaseous atmospheric attenuation was taken into account (Recommendation ITU-R SF.1395).

This study made the assumption that to compensate for additional propagation impairments in the main beam of the HAPS due to rain, the pfd mask can be increased in the corresponding beam by a value equivalent to the level of rain fading but limited to a maximum of 20 dB.

1. The wording above is subject to the conclusion of the correspondent activity on 1.14.

To verify the compliance with the propose pfd mask the following equation shall be used:

where:

EIRP: is the nominal HAPS platform EIRP spectral density in dBW/MHz (dependent to the elevation angle);

d: is the distance between the HAPS and the ground (elevation angle dependent).

The impact of the gas attenuation is not included in the verification formula since it is already taken into account in the pfd mask.

HAPS to ground (impact from FS station transmission into HAPS ground station receivers)

The study shows that the antennas used for both HAPS ground terminals and FS stations are directional, therefore, the required separation distance between the two systems can be reduced by appropriate site-configuration. Protection between HAPS ground stations and conventional FS stations can be managed on a case-by-case basis by coordination amongst administrations or usual link/planning method and procedures used at national level for conventional FS stations.

#### Sharing with Mobile Service (MS)

Ground to HAPS (impact from HAPS ground station transmission into MS station receivers)

The study concluded that HAPS ground stations (CPE/GW) can share with MS stations (BS and UE) as the maximum required separation distance is less than 400 m for p=20% and 500 m for p=0.01%.

Ground to HAPS (impact from MS station transmission into HAPS platform station receivers)

One study shows that the minimum separation distance of 65 km should be obeyed to avoid the interference and guarantee the quality of service, when both systems are pointing towards each other in azimuth.

HAPS to ground (impact from HAPS platform station transmission into MS station receivers)

The study shows that the following pfd mask in dBW/m2/MHz, to be applied under clear sky conditions at the surface of the Earth, ensures the protection of the Mobile Service receivers:

where El is elevation angle in degrees (angle of arrival above the horizontal plane).

Note that for the pfd level above, polarisation and gaseous atmospheric (ITU-R SF.1395) losses are considered. In addition, body loss is considered for the user equipment pfd level calculation.

This study made the assumption that to compensate for additional propagation impairments in the main beam of the HAPS due to rain, the pfd mask can be increased in the corresponding beam by a value equivalent to the level of rain fading.

To verify that the pfd produced by HAPS platform does not exceed the proposed pfd mask, the following equation shall be used:

where:

EIRP: is the nominal HAPS EIRP density level in dBW/MHz (dependent to the elevation angle);

d : is the distance between the HAPS and the ground (elevation angle dependent).

The impact of the gas attenuation, body loss (for user equipment), and polarization loss are not included in the verification formula since it is already taken into account in the pfd mask.

HAPS to ground (impact from MS station transmission into HAPS ground station receivers)

The study performed two different percentage of time, i.e., 20 % and 0.01 %, using propagation model ITU-R P.452. The study showed that for both cases, the impact of MS user equipment emissions into HAPS ground station receivers is in order of 4-14 km depending on the probability considered compared to 28-75 km between the MS and conventional FS station for the same probabilities. The impact of MS base station emissions into HAPS ground station receivers is in order of 2-17 km depending on the probability considered compared to 30-60 km between the MS and conventional FS station for the same probabilities. In addition, the required separation distance can be further reduced by appropriate site-configuration, due to HAPS antenna directivity. Therefore, protection between HAPS ground stations and MS stations can be managed on a case‑by-case basis by coordination amongst administrations at national level.

#### Sharing with Fixed Satellite Service (FSS)

Ground to HAPS (impact from HAPS ground station transmission into FSS Earth station receivers)

The study provides an assessment of potential interference from HAPS system ground stations using the same process that would be used in assessing interference from an FS station. The study shows that the impact of HAPS ground station emissions is less than the impact of an FS emitting station into FSS receiving Earth station.

The antennas used for both HAPS Gateway transmitters and FSS stations are directional, therefore, the required separation distance between the two systems can be reduced by appropriate site-configuration. Protection by HAPS ground stations of FSS Earth stations can be managed on a case-by-case basis by coordination amongst administrations or usual link/planning method and procedures used at national level for conventional FS stations.

Ground to HAPS (impact from FSS Space station transmission into HAPS platform station receivers)

The study shows that HAPS platform receivers will not be impacted and can accept interference from FSS downlink that are compliant with Table 21-4 of the RR Article 21.

HAPS to ground (impact from HAPS platform station transmission into FSS Earth station receivers)

According to the results of the analysis performed, HAPS technology can coexist with GSO FSS in the 38‑39.5 GHz band. This study proposed that for the purpose of protecting GSO FSS earth station in neighbouring administrations from co-channel interference, coordination of a transmitting HAPS station is required when, under assumed free-space conditions, the power-flux density over any point of an administration’s border exceeds the following values:

-169.9 + 1954 α² dB(W/(m²/MHz)) for 0 ≤ α < 0.136°

- 133.9 dB(W/(m²/MHz)) for 0.136° ≤ α < 1°

- 133.9 + 25 log α dB(W/(m²/MHz)) for 1° ≤ α < 47.9°

- 91.9 dB(W/(m²/MHz)) for 47.9° ≤ α ≤ 180°

where α is the minimum angle at the border between the line to the HAPS platform and the lines to the GSO arc in degrees

To calculate the pfd produced by a HAPS platform, the following equation shall be used:

where:

d : distance between the HAPS and the GSO FSS earth station (m);

Attgaz: attenuation to atmospheric gazes on the HAPS to GSO FSS earth station path (dB);

: required pfd at the GSO FSS earth station location to meet the FSS protection criteria (dB(W/(m².MHz));

EIRP: HAPS platform nominal EIRP spectral density in the direction of the GSO FSS earth station in dBW/MHz

According to the results of the analysis performed, HAPS technology can also coexist with NGSO FSS in the 38‑39.5 GHz band when taking into account the statistics of the NGSO FSS earth station pointing directions relative to the HAPS platform, and on the tracking strategy of the satellites by the NGSO FSS earth stations.

This study proposed that for the purpose of protecting NGSO FSS earth station in neighbouring administrations from co-channel interference, coordination of a transmitting HAPS station is required when the distance between the HAPS nadir and any point of an administration’s border is less than the predetermined coordination distance of 100 km.

HAPS to ground (impact from FSS Space station transmission into HAPS ground station receivers)

One study shows that HAPS receiving ground stations can coexist with FSS space stations emissions in the 38-39.5 GHz band given the percentage of HAPS service area where there could be potentially a problem and given mitigation techniques that could be implemented on the HAPS side.

## Report on studies on bands that are under possible consideration in Region 2 for HAPS (21.4-22 GHz and 24.25-27.5 GHz)

#### Compatibility with EESS (passive) in 21.2-21.4 GHz

HAPS to ground

Three independent studies show that compatibility between EESS (passive) sensors and HAPS platform downlinks is feasible provided that the unwanted emission e.i.r.p. from the HAPS platform in the band 21.2-21.4 GHz is below the following values:

where El is the elevation angle (°) at the platform height.

This e.i.r.p mask would cover all the transmissions from the HAPS platform (i.e. towards CPE and/or gateways) that could also have emissions in the direction of the EESS satellite. No apportionment of the EESS (passive) protection criterion was considered.

It was shown that at least one of the HAPS systems can meet such e.i.r.p. limit, based on the assumptions taken.

Ground to HAPS

In order to protect EESS (passive) in the bands 21.2-21.4 GHz, the unwanted emission e.i.r.p. of HAPS CPE should be below -33.4 dB(W/100 MHz), and the unwanted emission e.i.r.p. of HAPS gateways should be below -29.6 dB(W/100 MHz). Those numbers were actually obtained for the band 22.21-22.5 GHz but would also cover the band 21.2-21.4 GHz where studies are not yet completed.

#### Compatibility with EESS (passive) in 22.21-22.5 GHz

HAPS to ground

Three independent studies show that compatibility between EESS (passive) sensors and HAPS platform downlinks is feasible provided that the unwanted emission e.i.r.p. from the HAPS platform in the band 21.2-21.4 GHz is below the following values:

Two independent studies propose to consider the same unwanted emission e.i.r.p. mask as for the 21.2-21.4 GHz for the protection of EESS (passive) in the band 22.21-22.5 GHz from the HAPS platform:

where El is the elevation angle (°) at the HAPS platform height.

This e.i.r.p mask would cover all the transmissions from the HAPS platform (i.e. towards CPE and/or gateways) that could also have emissions in the direction of the EESS satellite. No apportionment of the EESS (passive) protection criterion was considered.

It was shown that at least one of the HAPS systems can meet such e.i.r.p. limit, based on the assumptions taken.

Ground to HAPS

In order to protect EESS (passive) in the bands 22.21-22.5 GHz, the unwanted emission e.i.r.p. of HAPS CPE should be below -33.4 dB(W/100 MHz), and the unwanted emission e.i.r.p. of HAPS gateways should be below -29.6 dB(W/100 MHz).

#### Compatibility of Radio Astronomy in the 22.21-22.5 GHz frequency range and HAPS systems operating in the 21.2-21.4 GHz frequency range

Ground to HAPS

A RAS station performing observations in the band 22.21-22.5 GHz can be protected from HAPS CPE and Gateways uplink transmissions in the band 21.4-22 GHz provided that those stations meet an unwanted emission pfd value of -146 dBW/m²/290 MHz for continuum observations and -162 dBW/m²/250 kHz for spectral line observations in the 22.21‑22.5 GHz band at the RAS station location at a height of 50 m. These pfd values shall be verified considering a percentage of time of 2% in the relevant propagation model. The possibilities for placement of HAPS ground stations may be affected by their situation with respect to the RAS station and HAPS platform.

HAPS to ground

A RAS station performing observations in the band 22.21-22.5 GHz can be protected from HAPS platforms downlink transmissions in the band 21.4-22 GHz provided that such HAPS platforms meet unwanted emission pfd values of -176 dBW/m²/290 MHz for continuum observations and -192 dBW/m²/250 kHz for spectral line observations in the 22.21-22.5 GHz band at the RAS station location. These pfd values shall be verified considering a percentage of time of 2% in the relevant propagation model.

#### Compatibility with EESS (passive) in 23.6 – 24.0 GHz

HAPS to ground

Four independent studies show that compatibility between EESS (passive) and HAPS platform downlinks is feasible provided that the unwanted emission e.i.r.p. from the HAPS platform in the band 23.6-24 GHz is below the following values:

where El is the elevation angle (°) at the platform height.

This e.i.r.p mask would cover all the transmissions from the HAPS platform (i.e. towards CPE and/or gateways) that could also have emissions in the direction of the EESS satellite. An apportionment of 5 dB of the EESS (passive) protection criterion was considered.

It was shown that at least one of the HAPS systems can meet such e.i.r.p. limit, based on the assumptions taken.

Ground to HAPS

In order to protect EESS (passive), the e.i.r.p. of HAPS CPE unwanted emissions falling in the band 23.6-24 GHz should be below -46 dBW/200 MHz, and the e.i.r.p. of HAPS CPE gateway unwanted emissions falling in the band 23.6-24 GHz should be below -39.9 dBW/200 MHz.

#### Sharing with EESS and SRS (space-to-Earth) Earth stations in 25.5 – 27 GHz

Studies have shown that in order to ensure the protection of in-band SRS/EESS satellite services from the HAPS platform or from the HAPS ground station in the band 25.5-27.0 GHz, the PFD of a HAPS should not exceed the sets of values below. The pfd limits applied to HAPS platforms are established to be met under clear sky conditions 100% of the time, at the location of the SRS/EESS earth station. For the case of the HAPS ground station towards an SRS/EESS Earth station path case there will be a need to consider HAPS and SRS/EESS antenna heights in order to apply attenuation using Recommendation ITU-R P.452, using the following percentages: 1) SRS: .001%; 2) EESS NGSO: .005%; 3) EESS GSO: 20%.

The SRS interference protection criteria are derived from Recommendation ITU-R SA.609. The EESS NGSO interference protection criteria are derived from the Recommendation ITU-R SA.1027 short-term criterion. The EESS GSO interference protection criteria are derived from the Recommendation ITU-R SA.1161 long-term criterion. The EESS and SRS pfd values calculated are shown below, which should be considered and acted upon, as appropriate.

Space Research Service

Where these equations are based on the SRS antenna gain towards the HAPS platform or the HAPS ground station following the Recommendation ITU-R SA.509 antenna pattern for an angle of arrival () of the interfering signal above the local horizontal plane at the SRS antenna.

Earth Exploration Satellite Service – NGSO:

Where these equations are based on the EESS antenna gain towards the HAPS platform or the HAPS ground station following the ITU-R RR Appendix 8, Annex 3 antenna pattern for an angle of arrival () of the interfering signal above the local horizontal plane at the EESS antenna.

Earth Exploration Satellite Service – GSO:

Where these equations are based on the EESS antenna gain towards the HAPS platform or the HAPS ground station following the ITU-R RR Appendix 8, Annex 3 antenna pattern for an angle of arrival () of the interfering signal above the local horizontal plane at the EESS antenna.

ESA is operating an SRS earth station in Region 2. This earth station located in Malargüe (Argentina) is located relatively close to the Chilean border and needs to be protected.

#### Sharing with ISS in 24.45 – 24.75 GHz

Ground to HAPS

One study was performed on sharing between HAPS and ISS in the 24.45‑24.75 GHz band. This single-entry study concludes that the EIRP from a single HAPS should be limited to 13.2 dBW/MHz under clear sky conditions (10.2 dBW/MHz per polarisation) in order to protect the ISS NGSO systems from a single HAPS. This study does not address dynamic, multiple entry scenarios. A first approximation on aggregate interference shows that EIRP from HAPS ground stations may be limited to 10.2 dBW/MHz under clear sky conditions (7.2 dBW/MHz per polarisation).

#### Sharing with ISS in 25.25 – 27.5 GHz

HAPS to ground

The CEPT study considered the potential emissions into the ISS space station receiver. The study included assessment for satellite receiver Io/No values of ‑10 dB. No assumption on the percentage of time associated to that interference level was needed.

The analysis performed shows that HAPS system downlink emissions will not impact the ISS receivers if the e.i.r.p. per HAPS platform transmitter is limited to -70.7 dBW/Hz for off Nadir angle higher than 90°.

Ground to HAPS

TBD

#### Sharing with FSS in the 24.75-25.25 GHz and 27-27.5 GHz

HAPS to ground

Two studies considered the potential emissions into the FSS space station receiver. The study included assessment for satellite receiver I/N values of ‑12.2 dB. No assumption on the percentage of time associated to that interference level was needed.

The analysis performed shows that HAPS system downlink emissions will not impact the FSS receivers if the e.i.r.p. per HAPS platform transmitter is limited to -10.8 dBW/MHz in any direction for off-nadir angle higher than 95°.

Ground to HAPS

TBD

#### Compatibility study of Radio Astronomy service in the 23.6-24 GHz band and HAPS systems operating in the 24.25-27.5 GHz frequency range

Ground to HAPS

A RAS station performing observations in the band 23.6-24 GHz can be protected from HAPS CPE and Gateways uplink transmissions in the band 24.25-27.5 GHz provided that those stations meet an unwanted emission pfd value of -147 dBW/m²/290 MHz for continuum observations and -161 dBW/m²/250 kHz for spectral line observations in the 23.6‑24 GHz band at the RAS station location at a height of 50 m. These pfd value shall be verified considering a percentage of time of 2% in the relevant propagation model. The possibilities for placement of HAPS ground stations may be affected by their situation with respect to the RAS station and HAPS platform.

HAPS to ground

A RAS station performing observations in the band 23.6-24 GHz can be protected from HAPS platforms downlink transmissions in the band 24.25-27.5 provided that such HAPS platforms meet unwanted emission pfd values of -177 dBW/m²/290 MHz for continuum observations and -191 dBW/m²/250 kHz for spectral line observations in the 23.6-24 GHz band at the RAS station location. These pfd values shall be verified considering a percentage of time of 2% in the relevant propagation model.

# List of relevant documents

ITU-Documentation (Recommendations, Reports, other)

* WP5C Chairman’s Report – Doc. 5C/531

Annex 11 - Work plan on WRC-19 Agenda Item 1.14

Annex 10 - Draft CPM text on WRC-19 Agenda Item AI 1.14

Annex 12 - PDNR ITU-R F.[HAPS Spectrum Needs]

Annex 14 - PDN Report/Rec. ITU-R F.[Broadband HAPS characteristics]

Annex 15 - PDNReport ITU-R F.[HAPS-6GHz] for sharing and compatibility studies in 6 440-6 520 MHz and 6 560-6 640 MHz

Annex 16 - PDNReport ITU-R F.[HAPS-21GHz] for sharing and compatibility studies in 21.4-22 GHz

Annex 17 - PDNReport ITU-R F.[HAPS-25GHz] for sharing and compatibility studies in 24.25-27.5 GHz

Annex 18 - PDNReport ITU-R F.[HAPS-31GHz] for sharing and compatibility studies in 27.9-28.2 GHz and 31.0-31.3 GHz

Annex 19 - PDNReport ITU-R F.[HAPS-39GHz] for sharing and compatibility studies in 38-39.5 GHz

Annex 20 - PDNReport ITU-R F.[HAPS-47GHz] for sharing and compatibility studies in the 47.2-47.5 and 47.9-48.2 GHz

* Existing ITU-R Recommendations/Reports

ITU-R P.1409

ITU-R F.1249, F.1500, F.1501, F.1509, F.1569, F.1570, F.1601, F.1607, F.1608, F.1609, F.1612, F.1764, F.1819, F.1820, F.1891, F.2011, ITU-R F.2240

ITU-R SF.1481, SF.1843.

ITU-R RA.769

CEPT and/or ECC Documentation (Decisions, Recommendations, Reports)

* ECC Report 156: Conditions for possible co-existence between HAPS gateway links and other services/systems in the 5850-7075 MHz band
* ECC Report 199: User requirements and spectrum needs for future European broadband PPDR systems (Wide Area Networks)

EU Documentation (Directives, Decisions, Recommendations, other), if applicable

# Actions to be taken

Promote CEPT view that any consideration of the frequency band 24.25-27.5 GHz under this Agenda item should not limit the possibility to identify the band for IMT on a global level under AI 1.13.

To establish CEPT view on the definition of HAPS given in No.1.66A in light of latest HAPS characteristics being proposed.

To review studies and conclude on the HAPS identification of the 38-39.5 GHz for the downlink directions including co-existence in the same geographical area between FSS and HAPS, in particular when used for connectivity applications.

# information from outside CEPT (examples of these are below)

## European Union (date of proposal)

## Regional telecommunication organisations

APT (June 2018)

Preliminary View

* APT Members support the ITU-R studies undertaken in accordance with Resolution 160 (WRC-15) on spectrum needs for High Altitude Platform Stations (HAPS), taking into account existing frequency bands that have already been identified for HAPS in the Radio Regulations, and appropriate regulatory actions.
* APT Members also support sharing and compatibility studies between HAPS and other services to ensure protection of the services to which frequency bands are allocated and their future developments.

ATU (October 2018)

Preliminary Position

Method B1/B2 which provides for the designation of certain fixed service bands for HAPS, in accordance with Resolution 160 (WRC-15) with options:

* Method B1 – an amended footnote for a worldwide identification of 27.9 - 28.2GHz and 31-31.3GHz, and an updated Resolution 122 to facilitate the use for HAPS in 47.2 - 47.5 GHz and 47.9-48.2 GHz.
* Method B2 – Add new designation(s) for HAPS in bands (38 - 39.5 GHz) already allocated to the FS with a primary status on a worldwide basis

Arab Group (April 2018)

ASMG Position is to support:

* On preliminary basis, no new frequency identifications for HAPS
* Following-up the on-going studies in ITU-R
* Emphasizing on the necessity of:

clarifying of technical and operational characteristics of HAPS

providing clear technical solutions for protecting the existing allocations from potential interference caused by HAPS.

studying the appropriateness of the previously identified frequency bands to the HAPS applications.

CITEL (July 2018)

Preliminary views from several countries supporting studies

Based on the outcome of studies, several support possible modifications to existing provisions and new identifications.

RCC (Oct 2018)

The RCC Administrations support the need to justify spectrum requirements for gateway stations’ and user links for HAPS to provide broadband connectivity in the fixed service taking into account frequency bands which have been already identified for HAPS.

The RCC Administrations support necessary modifications to existing RR Article 5 footnotes and related WRC Resolutions to facilitate HAPS development at global or regional level.

The RCC Administrations consider that in the case of modification to conditions for use of frequency bands authorized for HAPS or identification of new frequency bands for gateway and user links for HAPS, the protection and the possibility of further development shall be ensured for existing services, including other applications of fixed service, having allocations in these and adjacent frequency bands.

The RCC Administrations consider that HAPS should not claim more protection from other stations of existing services than that provided in the Radio Regulations for the terrestrial stations in the fixed service, while ensuring the same level of protection for stations of the existing services as the terrestrial stations in the fixed service provide.

## International organisations

IATA (date of proposal)

ICAO (16 September 16)

If agreed ITU-R studies demonstrate there is no adverse impact on aeronautical systems including those used for the safe operation of the platform on which the HAPS resides, then support the use of fixed service allocations for HAPS provided that any regulatory actions taken within the existing allocations to the fixed service noted in Resolution 160 (WRC-15) do not constrain the potential future use of those HAPS fixed links as part of aeronautical communication systems (e.g., VSAT enhancement).

IMO (date of proposal)

SFCG (August 2018)

SFCG Objective

SFCG prefers Method A, “no change.” Assuming that the ITU-R studies show a need for identification of additional spectrum for HAPS in Region 2, SFCG does not support the identification of frequency bands in 21.4-22 GHz and 24.25-27.5 GHz for HAPS, unless acceptable sharing conditions are agreed upon that do not adversely impact the space research, Earth exploration-satellite, or inter-satellite services.

As with WRC-19 agenda item 1.13, a particularly critical situation concerns the band 25.25-27.5 GHz which is heavily used globally for high data volume downlinks by many current and future EESS and SRS satellite missions. Within this band, inter-satellite links must also remain protected. This band is indicated as a candidate band for HAPS identification only for Region 2. If such an allocation is made, it should be accompanied by a WRC-19 Resolution which includes sufficient protection for these services. The Resolution should state that: “the provisions of No 5.536A shall not apply and the provisions of RR Nos. 9.17 and 9.18 shall apply. Administrations operating HAPS systems shall not claim protection from SRS/EESS stations operated by other administrations.” The resolution should have PFD limits which protect SRS/EESS services.

Identification of the band 24.25-27.5 GHz for HAPS under this agenda item must also be supported by studies showing the 21.2-21.4 GHz and 23.6-24.0 GHz EESS (passive) bands will be adequately protected from the HAPS unwanted emissions. The discussed above Resolution should contain EIRP density limits which protect these EESS (passive) services. Any revision of the current identifications for HAPS shall also continue to ensure that science services are protected.

EUMETNET (February 2018)

EUMETNET fully endorses the position of WMO given below.

WMO (February 2018)

WMO does not oppose new HAPS band identifications provided that studies show a need for identification of additional spectrum for HAPS and that protection of EESS (space-to-Earth) and EESS (passive) is ensured.

WMO requests that the long-term usage and future deployment of receiving EESS Earth stations (in particular in the 25.5-27 GHz band) should not be constrained by the HAPS usage.

WMO also requests that the necessary HAPS unwanted emission limits be established to ensure the protection of all current and future EESS (passive) sensors and included in table 1 of Resolution 750.

Furthermore, WMO would appreciate the development of a solution to ensure the continued operation of the ground-based radiometers in the 24.25-27.5 GHz frequency band.

## Regional organisations

ESA (October 2017)

ESA supports SFCG position.

EUMETSAT (October 2017)

EUMETSAT supports the SFCG and WMO position.

Eurocontrol (Nov 2018)

European Aeronautical Common Position (EACP):

If agreed ITU-R studies demonstrate there is no adverse impact on aeronautical systems including those used for the safe operation of the platform on which the HAPS resides, then support the use of fixed service allocations for HAPS provided that any regulatory actions taken within the existing allocations to the fixed service noted in Resolution 160 (WRC-15) do not constrain the potential future use of those HAPS fixed links as part of aeronautical communication systems (e.g. VSAT enhancement).

## OTHER INTERNATIONAL AND REGIONAL ORGANISATIONS

EBU (date of proposal)

CRAF (November 2018)

CRAF supports the protection of RAS in the bands 6650.0 - 6675.2 MHz, 31.3 - 31.5 GHz and 48.94-49.04 GHz as well as the RAS operations in other regions in the bands 22.01 – 22.50 GHz, 23.6 – 24 GHz. CRAF supports the implementation of obligatory PFD limits in the Radio Regulations for HAPS systems to meet in order to protect the RAS frequency bands.

NATO (November 2018)

NATO Military Assessment

* From a military perspective, care must be taken to ensure the adequate protection of critical space assets and to avoid encroachment into NJFA and military used frequency bands including the 38-39.5 GHz band currently used or planned for use by NATO. Moreover, several NATO nations operate critical airborne data links in the 21.2-21.5 GHz band that overlap the 21.4-22 GHz band.

NATO Position

* NATO supports the allocation of additional frequencies for HAPS throughput applications whilst ensuring that existing NATO systems/applications in targeted and adjacent bands are not adversely impacted.
1. See ECC Report 199 for more details on broadband PPDR spectrum requirements within CEPT. [↑](#footnote-ref-1)
2. See ECC Report 199 for more details on broadband PPDR spectrum requirements within CEPT. [↑](#footnote-ref-2)
3. Australia, Burkina Faso, Cote d'Ivoire, Mali and Nigeria [↑](#footnote-ref-3)
4. The space research service is also subject to these protections in the following countries: Armenia, Georgia, Kyrgyzstan, Tajikistan and Turkmenistan. [↑](#footnote-ref-4)