**UNITED STATES OF AMERICA**

**DRAFT PROPOSAL FOR THE WORK OF THE CONFERENCE**

**Agenda Item 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.*

# BACKGROUND

No. 1.66A of the ITU Radio Regulations define a high-altitude platform station (HAPS) as "a station on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth". Agenda Item 1.14 was adopted by WRC-15 to consider, in accordance with Resolution 160 (WRC-15), regulatory actions that can facilitate deployment of HAPS for broadband applications. Resolution 160 resolves to invite ITU-R to study additional spectrum needs of HAPS, examining the suitability of existing HAPS designations and conducting sharing and compatibility studies for additional designations in existing fixed allocations in the 38-39.5 GHz band on a global basis and in 21.4-22 GHz and 24.25-27.5 GHz bands in Region 2 exclusively.

Currently there are 3 spectrum bands identified for HAPS in the fixed services. These are:

- 47.2–47.5 GHz and 47.9 48.2 GHz,

- 27.9-28.2 GHz (HAPS-ground) and 31.0-31.3 GHz (ground-HAPS)

- 6 440–6 520 MHz (HAPS-ground) and 6 560-6 640 MHz (ground-HAPS).

However, spectrum needs of next-generation HAPS cannot be accommodated within these designations due to either geographical restrictions or technical limitations which impairs their operation. The global designations for HAPS links (which is in the 47.2-47.5 GHz band fixed-service allocation paired with the 47.9-48.2 GHz band fixed-service allocation) suffers from the effects of rain fade attenuation that severely limit service provision over high-precipitation geographies. The remaining 2 available bands (27.9-28.2 GHz paired with the frequency band 31.0-31.3 GHz, and 6440-6 520 MHz paired with 6 560-6 640 MHz) have been identified by a limited number of countries, none of which is within ITU Region 2. The ITU-R developed a Preliminary New Draft Recommendation (PDNR) assessing spectrum needs for broadband HAPS at an approximate 4 GHz aggregate capacity. The following proposals encourage the designation of HAPS in the fixed service allocations on a co-primary basis to facilitate investment in and deployment of HAPS, while ensuring protection to systems of other services allocated in the band as well as not providing priority to HAPS over other uses within the services allocated on a primary basis.

**BROADBAND HAPS APPLICATIONS**

Advances in aeronautics and transmission technologies have significantly improved the capabilities of HAPS to provide effective connectivity solutions and meet the growing demand for high capacity broadband networks, particularly in currently underserved areas. Recently conducted full-scale test flights have shown that solar-powered platforms in the upper-atmosphere can now be used to carry payloads that offer connectivity over large areas in a reliable and cost-effective way, and a growing number of applications for the new generation of HAPS are being developed. The technology appears particularly well suited to complementing terrestrial networks by providing backhaul. A number of advantages of the new generation of HAPS are foreseen:

* **Wide-area coverage:** A single platform will be able to serve footprints larger than 100 km in diameter, and recent technological advances in the development of optical inter-HAPS links now allow the deployment of multiple linked HAPS, in fleets that can cover whole nations.
* **Low cost:** The cost of operating stratospheric platforms is projected to be significantly lower than other connectivity solutions in many areas, while mass production of the aircraft will significantly lower upfront capital expenditure for deployment.
* **Reach:** HAPS platforms will operate at around 20 km above ground, which reduces their vulnerability to weather conditions that may affect service, provides large coverage areas and avoids interference caused by physical obstacles.
* **Rapid deployment and flexibility:** It will be possible to deploy HAPS services without long lead times and it is relatively simple to return solar platforms to the ground for maintenance or payload reconfiguration.
* **Geographical reach:** HAPS that use the architecture of solar platforms can also provide connectivity where it is impossible to deploy terrestrial infrastructure: remote sites on land or sea.
* **Environmentally friendly:** HAPS can run exclusively on solar power for long periods, connecting people with almost no environmental impact.

Spectrum harmonization and utilization is facilitated by common worldwide designations. International regulatory flexibility can enable improvements in global connectivity by encouraging national regulators to permit operation of higher-speed Internet access services over new, complementary platforms, while ensuring protection of existing services. Additionally, harmonization of spectrum promotes economies of scale and commonality of equipment.

Broadband HAPS can also be used for:

* Response to natural disasters.
* Fire detection, monitoring, and firefighting.
* Law enforcement with communication needs across local actors and regional headquarters.
* Resource exploration missions for communication between exploration teams and regional home base.

**SHARING STUDIES**

A number of administrations and technology proponents have conducted compatibility studies to assess coexistence between HAPS and incumbent and proposed systems and services (including WRC-19 Agenda Items 1.6 and 1.13).

A power-flux density (PFD) threshold would be used to ensure the protection of the fixed and mobile services from downlink emissions by HAPS platforms (HAPS-to-ground), which if exceeded would require coordination with neighboring administrations and their explicit agreement. This PFD ensures that the signal level produced by HAPS systems at the location of fixed and mobile service stations will not cause interference. Protection from uplink emissions by HAPS ground stations with other stations of the fixed service or mobile service could be ensured through coordination at the national level, based on the relatively short separation distances (and other mitigation techniques) provided by the studies.

The protection of FSS satellite networks on a co-channel basis appears to be feasible if the frequency bands used by a HAPS network is transmitting in an opposite direction from that of the FSS satellite network (i.e., satellite Earth-to-space with HAPS-to-ground, and satellite space-to-Earth with ground-to-HAPS). In these cases, some studies suggest that satellite stations can be protected from HAPS-to-ground emissions, while relatively short separation distances can be used to protect Earth stations from ground-to-HAPS emissions through station coordination amongst administrations or usual link planning procedures used at a national level. In the case of national level coordination, the use of mitigation techniques and/or geographical separation could be used to enable deployments by either service.

For the protection of science services (EESS, SRS, RAS), radiated power limits and coordination amongst administrations could be used to ensure the protection of these services. The receiving earth station for EESS and SRS can be protected through coordination. In the case of science services operating in adjacent bands to HAPS, specific limits on out-of-band emissions for both HAPS platforms and ground stations can be used to ensure their protection.

# 1. **PROPOSALS FOR THE 6 GHZ BANDS**

## For the 6 440 – 6 520 MHz Band:

### NOC **USA/1.14/1**

ARTICLE 5

Frequency allocations

**Reasons**: To maintain the existing designation for HAPS without modifications.

### NOC USA/1.14/2

RESOLUTION 150 (WRC‑12)

Use of the bands 6 440-6 520 MHz and 6 560-6 640 MHz by gateway links   
for high-altitude platform stations in the fixed service

**Reasons**: To maintain the existing designation for HAPS without modifications.

## For the band 6 560–6 640 MHz Band:

### NOC USA/1.14/4

ARTICLE 5

Frequency allocations

**Reasons**: To maintain the existing designation for HAPS without modifications.

### NOC USA/1.14/5

RESOLUTION 150 (WRC‑12)

Use of the bands 6 440-6 520 MHz and 6 560-6 640 MHz by gateway links   
for high-altitude platform stations in the fixed service

**Reasons**: To maintain the existing designation for HAPS without modifications.

# 2. PROPOSALS FOR THE 21.4 – 22 GHZ BAND

### MOD USA/1.14/6

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations  
(See No. 2.1)

18.4-22 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 21.4-22  FIXED  MOBILE  BROADCASTING-SATELLITE 5.208B  5.530A 5.530B 5.530D | 21.4-22  FIXED ADD 5.B114  MOBILE  5.530A | 21.4-22  FIXED  MOBILE  BROADCASTING-SATELLITE 5.208B  5.530A 5.530B 5.530D 5.531 |

**Reasons**: To add a footnote to the fixed service allocation in support of a HAPS designation in the 21.4 -22 GHz band.

### ADD USA/1.14/7

5.B114 The allocation to the fixed service in the band 21.4-22 GHz is designated for use in Region 2 by high-altitude platform stations (HAPS). This designation does not preclude the use of this frequency band by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Such use of the fixed-service allocation by HAPS is limited to the HAPS-to-ground direction in the 21.4 -22 GHz band. Such use is subject to the provisions of Resolution**[B114] (WRC‑19)**.     (WRC‑19)

**Reasons**: To add the text of the footnote allowing HAPS to operate in the fixed service allocation in the 21.4-22 GHz band.

## Draft new Resolution for the 21.4-22 GHz band

### ADD USA/1.14/8

DRAFT NEW RESOLUTION [B114] (WRC‑19)

Use of the band 21.4-22 GHz by high altitude platform   
stations in the fixed service for Region 2

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

*a)* that WRC-15 considered that there is a need for greater broadband connectivity in underserved communities and in rural and remote areas, that current technologies can be used to deliver broadband applications by high-altitude platform stations (HAPS), which can provide broadband connectivity and disaster recovery communications with minimal ground network infrastructure;

*b)* that WRC-15 decided to study additional spectrum needs for fixed HAPS links to provide broadband connectivity, including within the band 21.4-22 GHz, recognizing that the existing HAPS designations were established without reference to today’s broadband capabilities;

*c)* that HAPS can provide broadband connectivity with minimal ground network infrastructure;

*d)* that compatibility with existing services allocated on a primary basis in the frequency range 21.2-22.5 GHz must be ensured when introducing any new HAPS designations,

*e)* that Recommendation ITU-R P.618, “Propagation data and prediction methods required for the design of Earth-space telecommunication systems”, should be used to determine rain attenuation from HAPS platforms.

recognizing

*a)* that RR No. **5.532** requires that the use of the band 22.21-22.5 GHz by the Earth Exploration-Satellite (passive) and space research (passive) services shall not impose constraints upon the fixed and mobile, except aeronautical mobile, services;

*b)* that HAPS is defined in No. **1.66A** of the Radio Regulations as a station located on an object at an altitude of 20-50 km and at a specified, nominal, fixed point relative to the Earth, and is subject to No. **4.23**,

*c)* that the band 21.4-22 GHz is also allocated to mobile service on a co-primary basis;

resolves

1. that for the purpose of protecting fixed service systems in neighboring administrations in the band 21.4-22 GHz, the power flux density level per HAPS platform station produced at the surface of the Earth in neighboring administrations shall not exceed the following pfd mask in dBW/m2/MHz, under clear sky condition, without the explicit agreement from the affected administration:

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

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

where:

*d* distance in meters between the HAPS and the ground (elevation angle dependent);

*EIRP* HAPS platform nominal EIRP spectral density in dBW/MHz at a specific elevation angle;

*pfd(El)* is the power flux density at the Earth’s surface per HAPS platform station in dBW/m2/MHz.

*rain fade*  rain attenuation in dB (ITU-R P.618)

2 that in order to ensure the protection of EESS (passive), the EIRP per HAPS platform, in the bands 21.2-21.4 GHz and 22.21-22.5 GHz, shall not exceed:

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

3 that in order to ensure the protection of the radio astronomy service, the unwanted emission pfd produced by HAPS platform downlink transmissions shall not exceed -176 dBW/m²/290 MHz for continuum observations, and -192 dBW/m²/250 kHz for spectral line observations in the band 22.21-22.5 GHz at an RAS station location at a height of 50m. These pfd values shall be verified considering a percentage of time of 2% in the relevant propagation model;

4 that *resolves 3* above applies at any radio astronomy station that was in operation prior to 22 November 2019; and that has been notified to the Bureau in the band 22.21-22.5 GHz before 22 May 2020. Radio astronomy stations notified after this date may seek an agreement with administrations that have notified HAPS,

*invites ITU-R*

to develop ITU-R Reports that will assist administrations in facilitating coexistence with other co-primary services; and

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution.

**Reasons**: To add the text of a resolution specifying the operating requirements for HAPS to protect other services.

# 3. PROPOSALS FOR THE 24.25-27.5 GHZ BAND

## For the 24.25-25.25 GHz Band

### MOD USA/1.14/9

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations  
(See No. 2.1)

**24.25-25.25 GHz**

|  |  |  |
| --- | --- | --- |
| **Allocation to services** | | |
| **Region 1** | **Region 2** | **Region 3** |
| **24.25-24.45**  FIXED | **24.25-24.45**  FIXED ADD 5.C114  RADIONAVIGATION | **24.25-24.45**  RADIONAVIGATION  FIXED  MOBILE |
| **24.45-24.65**  FIXED  INTER-SATELLITE | **24.45-24.65**  FIXED ADD 5.C114  INTER-SATELLITE  RADIONAVIGATION | **24.45-24.65**  FIXED  INTER-SATELLITE  MOBILE  RADIONAVIGATION |
|  | 5.533 | 5.533 |
| **24.65-24.75**  FIXED  FIXED-SATELLITE (Earth-to-space) 5.532B  INTER-SATELLITE | **24.65-24.75**  FIXED ADD 5.C114  INTER-SATELLITE  RADIOLOCATION- SATELLITE (Earth-to-space) | **24.65-24.75**  FIXED  FIXED-SATELLITE (Earth-to-space) 5.532B  INTER-SATELLITE  MOBILE |
|  |  | 5.533 |
| 24.75-25.25  FIXED  FIXED-SATELLITE (Earth-to-space) 5.532B | 24.75-25.25  FIXED ADD 5.C114  FIXED-SATELLITE (Earth-to-space) 5.535 | 24.75-25.25  FIXED  FIXED-SATELLITE (Earth-to-space) 5.535  MOBILE |

**Reasons**: To add a primary fixed service allocation to the 24.25-25.25 GHz band, in order to support a HAPS designation in that band.

### ADD USA/1.14/10

**5.C114** The allocation to the fixed service in the band 24.25-25.25 GHz is designated for and limited to use in Region 2 by high-altitude platform stations (HAPS). Such use of the fixed-service allocation by HAPS is limited to operation in the HAPS-to-ground direction and is subject to the provisions of Resolution **[C114] (WRC-19)**.

**Reasons:** To add the text of the footnote allowing HAPS to operate in the fixed service allocation in the 24.25-25.25 GHz band. The limitation of the use of HAPS in the HAPS-to-ground direction in the 24.25-25.25 GHz band is to ensure the protection of the:

* FSS operating in the 24.75-25.25 GHz band;
* ISS operating in the 24.45-24.75 GHz band;
* EESS passive operating in the 23.6-24 GHz band.

## For the 25.25-27.5 GHz Band

### MOD USA/1.14/11

ARTICLE 5

**Frequency allocations**

**Section IV – Table of Frequency Allocations**(See No. **2.1**)

**25.25-27.5 GHz**

|  |  |  |
| --- | --- | --- |
| **Allocation to services** | | |
| **Region 1** | **Region 2** | **Region 3** |
| **25.25-25.5** FIXED ADD 5.D114  INTER-SATELLITE 5.536  MOBILE  Standard frequency and time signal-satellite (Earth-to-space) | | |
| **25.5-27** EARTH EXPLORATION-SATELLITE (space-to Earth) 5.536B  FIXED ADD 5.D114  INTER-SATELLITE 5.536  MOBILE  SPACE RESEARCH (space-to-Earth) 5.536C  Standard frequency and time signal-satellite (Earth-to-space)  5.536A | | |
| **27-27.5**  FIXED  INTER-SATELLITE 5.536  MOBILE | **27-27.5**  FIXED ADD 5.D114  FIXED-SATELLITE (Earth-to-space)  INTER-SATELLITE 5.536 5.537  MOBILE | |

**Reasons:** To add a footnote to the 25.25-27.5 GHz band in Region 2 allowing HAPS to operate in the fixed service allocation.

### ADD USA/1.14/12

**5.D114** The allocation to the fixed service in the bands 25.25-25.5 GHz, 25.5-27.0 GHz and 27.0-27.5 GHz is designated for use in Region 2 by high-altitude platform stations (HAPS). This designation does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Such use of the fixed-service allocation by HAPS is limited to operation in the ground-to-HAPS in the frequency range 25.25-27 GHz, and HAPS-to-ground in the band 27.0-27.5 GHz. Such use of the fixed-service allocation by HAPS is subject to the provisions of Resolution **[C114] (WRC-19)**.

**Reasons:** To add the text of the footnote allowing HAPS to operate in the fixed service allocation in the 25.25-27.5 GHz band. The limitation of the use of HAPS in the ground-to-HAPS direction in the 25.25-27 GHz band is to ensure the protection of EESS/SRS services operating in the 25.5-27 GHz band. The limitation of the use of HAPS in the HAPS-to-ground direction in the 27-27.5 GHz band is to ensure the protection of the FSS operating in the same band.

## Draft new Resolution for the 24.25-27.5 GHz band

### ADD USA/1.14/13

DRAFT NEW RESOLUTION [C114]

**Use of the frequency range 24.25-27.5 GHz by fixed links for high altitude   
platform stations in the fixed service in Region 2**

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

*considering*

*a)* that WRC-15 considered that there is a need for greater broadband connectivity in underserved communities and in rural and remote areas, that current technologies can be used to deliver broadband applications by high-altitude platform stations (HAPS), which can provide broadband connectivity and disaster recovery communications with minimal ground network infrastructure;

*b)* that WRC-15 decided to study additional spectrum needs for fixed HAPS links to provide broadband connectivity, including within the band 24.25-27.5 GHz in Region 2, recognizing that the existing HAPS designations were established without reference to today’s broadband capabilities;

*c)* that HAPS can provide broadband connectivity with minimal ground network infrastructure;

*d)* that Recommendation ITU-R P.618, “Propagation data and prediction methods required for the design of Earth-space telecommunication systems”, should be used to determine rain fade attenuation from HAPS platforms;

*e)* that Recommendation ITU-R P.452, “Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz”, should be used to determine the propagation loss in the ground path from HAPS ground stations;

*f)* that Recommendation ITU-R SF.1395, “Minimum propagation attenuation due to atmospheric gases for use in frequency sharing studies between the fixed-satellite service and the fixed service”, should be used to determine the gaseous attenuation;

*g)* that Recommendation ITU-R P.2108, “Prediction of Clutter Loss”, should be used to determine the clutter loss,

*recognizing*

1. that HAPS is defined in No. **1.66A** of the Radio Regulations as a station located on an object at an altitude of 20-50 km and at a specified, nominal, fixed point relative to the Earth, and is subject to No. **4.23**;
2. that in the band 27.0-27.5 GHz with respect to earth stations in the Fixed-Satellite Service (Earth-to-space) and HAPS ground station receivers which operate in the Fixed Service, Nos. **9.17** and **9.18** applies;

*resolves*

1 that for the purpose of protecting the fixed service systems in neighboring administrations in the frequency range 24.25-27.5 GHz, the power flux density level per HAPS platform station at the surface of the Earth in neighboring administrations shall not exceed the following pfd mask in dBW/m2/MHz, under clear sky condition, without the explicit agreement from the affected administration:

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

To verify the compliance with the 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 in meters between the HAPS and the ground (elevation angle dependent);

*pfd()* power flux density at the Earth surface per HAPS platform station in dBW/m²/MHz;

*rain fade* rain attenuation in dB (ITU-R P.618)

2 that for the purpose of protecting the terrestrial mobile service systems in neighboring administrations in the band 24.25-27.5 GHz, the power flux density level per HAPS platform station at the surface of the Earth in neighboring administrations shall not exceed the following pfd masks in dBW/m2/MHz for more than 0.1% of deployment, without the explicit agreement from the affected administration:

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

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

where:

*d* distance in meters between the HAPS and the ground (elevation angle dependent);

*EIRP* HAPS platform nominal EIRP spectral density in dBW/MHz at a specific elevation angle;

*pfd()* power flux density at the Earth surface per HAPS platform station in dBW/m²/MHz;

*Lpol* polarization loss of 3 dB;

*Bloss* body loss of 4 dB;

*GasAtt(El)* gaseous attenuation;

*rain fade* rain attenuation in dB (ITU-R P.618)

3 that for the purpose of protecting the Inter Satellite service, the EIRP density per HAPS platform in the band 24.45-24.75 GHz, shall not exceed -19.9 dBW/MHz above 85 degree off-nadir; the EIRP density per HAPS platform in the bands 27-27.5 GHz, shall not exceed -70.7 dBW/Hz for off-nadir angle higher than 85°; and the EIRP density per HAPS ground station in the band 25.25-27 GHz, shall not exceed 13.5 dBW/MHz towards the ISS GSO receiver under clear sky conditions;

4 that for the purpose of protecting the Fixed Satellite service, the EIRP density per HAPS platform, in the bands 24.75-25.25 and 27-27.5 GHz, shall not exceed -9.1 dBW/MHz for off‑nadir angle higher than 85°;

5 that in the band 24.75-25.25 GHz, Nos. **9.17** and **9.18** do not apply with respect to the Fixed Service allocation and in the band 27.0-27.5 GHz, Nos. **9.17** and **9.18** do not apply to the HAPS designation of the Fixed Service Allocation; HAPS ground stations shall not claim protection from Fixed-Satellite Service earth stations transmitting in the bands 24.75-25.25 GHz and 27.0-27.5 GHz in neighbouring administrations, and No. 5.43A shall not apply;

6 that for the purpose of protecting the Earth Exploration Satellite passive services the EIRP in the band 23.6-24 GHz per HAPS platform, operating in the band 24.25-25.25GHz, shall not exceed:

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

7 that with respect to HAPS, the provisions of No. **5.536A** shall not apply;

8 that in order to ensure the protection of in-band SRS/EESS satellite services from a HAPS ground station in the band 25.5-27.0 GHz, the PFD shall not exceed the threshold values below at the SRS/EESS earth stations. The EESS PFD threshold values shall be applied at earth stations which only support EESS operations. If the PFD threshold values below are exceeded, then HAPS shall coordinate in accordance with No. 9.18, taking into account the parameters of the relevant systems.

**SRS**

**EESS NGSO**

**EESS GSO**

For the HAPS ground station towards an SRS/EESS Earth station, attenuation using the relevant ITU-R propagation Recommendations shall be applied using the following percentages: 1) SRS: .001%; 2) EESS NGSO: .005%; 3) EESS GSO: 20%, and the HAPS and SRS/EESS antenna heights shall be used in this calculation.

9 in order to ensure the protection of the radio astronomy service, the pfd produced by unwanted emissions from HAPS platform downlink transmissions operating in the band 24.25-25.25 GHz shall not exceed -177 dB W/m²/400 MHz for continuum observations and -191 dB W/m²/250 kHz for spectral line observations in the band 23.6-24 GHz at an RAS station location at the height of 50 m. These pfd values shall be verified considering a percentage of time of 2% in the relevant propagation model.

To verify the compliance the following formula shall be used:

where

*EIRPmax clear sky* is the maximum EIRP towards the RAS station at which the HAPS platform station operates under clear sky condition in dBW/290 MHz for continuum observations and in dBW/250 kHz for spectral line observations in the band 23.6-24 GHz;

*Az* is the azimuth in degrees from the HAPS platform toward the RAS station;

*El* is the elevation angle in degrees at the HAPS platform towards the RAS station;

*Att618p=2%* is the attenuation in dB from recommendation 618 corresponding to p=2% of the time at the radio astronomy location;

*d* is the separation distance in meters between the HAPS platform;

*pfd* is thepower flux density at the Earth surface per HAPS platform station in dBW/m²/290 MHz for continuum observations and in dBW/m²/250 kHz for spectral line observations in the band 23.6-24 GHz;

10 that *resolves 9* shall apply at any radio astronomy station that was in operation prior to 22 November 2019 and has been notified to the Bureau in the band 23.6-24 GHz before 22 May 2020. Radio astronomy stations notified after this date may seek an agreement with administrations that have authorized HAPS,

*invites ITU-R*

to develop ITU-R Reports that will assist administrations in facilitating coexistence with other services

*instructs the Director of the Radiocommunication Bureau*

to take all necessary measures to implement this Resolution.

**Reasons:** To add the text of a resolution specifying the operating requirements for HAPS to protect other services to protect other services for the directions indicated in the Article 5 footnotes.

# 4. PROPOSALS FOR THE 28 / 31 GHZ BANDS

## For the 27.9-28.32 GHz Band

### MOD USA/1.14/14

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations  
(See No. 2.1)

24.75-29.9 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |

|  |
| --- |
| 27.5-28.5 FIXED ADD 5.E114  FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539  MOBILE  5.538 5.540 |

**Reasons**: To add a footnote to the fixed service allocation in support of a HAPS designation in the 27.9-28.2 GHz band and to suppress the existing HAPS related footnote.

### ADD USA/1.14/15

5.E114The allocation to the fixed service in the band 27.9-28.2 GHz is designated for worldwide use by high-altitude platform stations (HAPS). This designation does not preclude the use of this frequency band by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Such use of the fixed-service allocation by HAPS is limited to operation in the HAPS-to-ground direction and is subject to the provisions of Resolution **[E114] (WRC‑19)**.     (WRC‑19)

**Reasons:** To add the text of the footnote allowing HAPS to operate in the fixed service allocation in the 27.9-28.2 GHz band on a worldwide basis.

### SUP USA/1.14/16

5.537A

## For the 31.0-31.3 GHz Band

### MOD USA/1.14/17

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations  
(See No. 2.1)

29.9-34.2 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 31-31.3 FIXED 5.338A ADD 5.F114  MOBILE  Standard frequency and time signal-satellite (space-to-Earth)  Space research 5.544 5.545  5.149 | | |

**Reasons**: To add a footnote to the fixed service allocation in support of a HAPS designation in the 31-31.3 GHz band and to suppress the existing HAPS related footnote.

### ADD USA/1.14/18

5.F114The allocation to the fixed service in the band 31-31.3 GHz is designated for worldwide use by high-altitude platform stations (HAPS) in the HAPS-to-ground direction. This designation does not preclude the use of this frequency band by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Such use of the fixed-service allocation by HAPS is subject to the provisions of Resolution **[E114] (WRC‑19)**.     (WRC‑19)

**Reasons:** To add the text of the footnote allowing HAPS to operate in the fixed service allocation in the 31-31.3 GHz band on a worldwide basis.

### SUP USA/1.14/19

5.543A

## Draft new Resolution for the 27.9-28.2 and 31-31.3 GHz bands

### ADD USA/1.14/20

DRAFT NEW RESOLUTION [E114] (WRC‑19)

Use of the bands 27.9-28.2 GHz and 31-31.3 GHz by high altitude platform stations in the fixed service

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

considering

*a)* that WRC-15 considered that there is a need for greater broadband connectivity in underserved communities and in rural and remote areas, that current technologies can be used to deliver broadband applications by high-altitude platform stations (HAPS), which can provide broadband connectivity and disaster recovery communications with minimal ground network infrastructure;

*b)* that WRC-15 decided to study additional spectrum needs for fixed HAPS links to provide broadband connectivity, including the existing designations in the 27.9-28.2 GHz and the 31-31.3 GHz bands, recognizing that the existing HAPS designations were established without reference to today’s broadband capabilities;

1. that HAPS can provide broadband connectivity with minimal ground network infrastructure;

*d)* that Recommendation ITU-R P.618, “Propagation data and prediction methods required for the design of Earth-space telecommunication systems”, should be used to determine rain fade attenuation from HAPS platforms;

*e)* that Recommendation ITU-R P.452, “Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz”, should be used to determine the propagation loss in the ground path from HAPS ground stations;

*f)* that Recommendation ITU-R SF.1395, “Minimum propagation attenuation due to atmospheric gases for use in frequency sharing studies between the fixed-satellite service and the fixed service”, should be used to determine the gaseous attenuation;

*g)* that Recommendation ITU-R P.2108, “Prediction of Clutter Loss”, should be used to determine the clutter loss,

*recognizing*

*a)* that HAPS is defined in No. **1.66A** of the Radio Regulations as a station located on an object at an altitude of 20-50 km and at a specified, nominal, fixed point relative to the Earth, and is subject to No. **4.23**,

resolves

1 that for the purpose of protecting the fixed wireless systems in neighboring administrations in the band 27.9-28.2 GHz, the power flux density level per HAPS platform station at the surface of the Earth in neighboring administrations shall not exceed the following pfd mask in dBW/m2/MHz, under clear sky condition, without the explicit agreement from the affected administration:

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

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

where:

*d* is the distance in meters between the HAPS and the ground;

*e.i.r.p* HAPS platform nominal EIRP spectral density in dBW/MHz at a specific elevation angle

*pfd(El)* power flux density at the Earth surface per HAPS platform station in dBW/m²/MHz;

*rain fade* rain attenuation in dB (ITU-R P.618)

2 that for the purpose of protecting the terrestrial mobile service systems in neighboring administrations in the band 27.9-28.2 GHz band, the power flux density level per HAPS platform station at the surface of the Earth in neighboring administrations shall not exceed the following pfd masks in dBW/m2/MHz for more than 0.1% of deployment, without the explicit agreement from the affected administration:

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

where:

*d* distance in meters between the HAPS and the ground (elevation angle dependent);

*e.i.r.p.* HAPS platform nominal EIRP spectral density in dBW/MHz at a specific elevation angle;

*pfd(El)* power flux density at the Earth surface per HAPS platform station in dB(W/m²/MHz);

*Lpol* polarization loss of 3 dB;

*Bloss* polarization loss of 4 dB;

*GasAtt(El)* gaseous attenuation (ITU-R SF.1395);

*rainfade* rain attenuation in dB (ITU-R P.618).

3 that for the purpose of protecting the fixed satellite service (Earth-to-space) in the 27.9‑28.2 GHz, the maximum EIRP density per HAPS platform shall be less than -8 dBW/MHz for off-nadir angle higher than 85°;

4that HAPS ground stations shall not claim protection from fixed-satellite service earth stations transmitting in the 27.9-28.2 GHz band, and No. 5.43A shall not apply;

5 that for the purpose of protecting the fixed service systems in neighboring administrations in the band 31-31.3 GHz, the power flux density level per HAPS platform station at the surface of the Earth in neighboring administrations shall not exceed the following pfd mask in dBW/m2/MHz, under clear sky condition, without the explicit agreement from the affected administration:

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

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

where:

*d* distance in meters between the HAPS and the ground (elevation angle dependent);

*e.i.r.p.* HAPS platform nominal EIRP spectral density in dBW/MHz at a specific elevation angle;

*pfd(El)* power flux density at the Earth surface per HAPS platform station in dB(W/m²/MHz);

*rainfade* rain attenuation in dB (ITU-R P.618).

6 that in order to ensure the protection of EESS (passive) per RR.5.543A, the level of unwanted power density into the HAPS ground station antenna in the band 31.3-31.8 GHz shall be limited to −83 dB(W/200 MHz) 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;

7 that in order to ensure the protection of EESS (passive) services the EIRP per HAPS platform, in the band 31.3-31.8 GHz, shall not exceed:

8 that in order to ensure the protection of the radio astronomy service, the pfd level produced by any HAPS ground station at the RAS stations listed, shall not exceed   
-141 dBW/m2/500MHz in the band 31.3-31.8 GHz, unless a higher pfd is otherwise agreed between the corresponding administrations;

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

where:

*AttRe*c P.452-16 attenuation in dB based on Recommendation ITU-R P.452-16 propagation model with p = 2%;

e.i.r.p. maximum HAPS EIRP density level in dBW/MHz/500MHz (dependent to the elevation angle);

*d* distance in meters between the HAPS and the ground (Elevation angle dependent);

*pfd(El)* power flux density at the Earth surface per HAPS platform station in dB(W/m²/500MHz);

9 that in order to ensure the protection of the radio astronomy service the pfd produced by unwanted emissions from HAPS platform downlink transmissions shall not exceed   
-171 dB W/m²/500 MHz for continuum observations in the band 31.3-31.8 GHz at an RAS station location at a height of 50m, where this pfd value shall be verified considering a percentage of time of 2% in the relevant propagation model;

To verify the compliance the following formula shall be used:

where:

*EIRPmax clear sky.* maximum EIRP towards the RAS station at which the HAPS platform station operates under clear sky condition in dB(W/500 MHz);

*Az* azimuth from the HAPS platform toward the RAS station;

*El:* is the elevation angle at the HAPS platform towards the RAS station;

*Att618p=2%:* attenuation from recommendation 618 corresponding to p=2% of the time at the radio astronomy location;

*d* separation distance in m between the HAPS platform and the RAS station;

*pfd(El)* power flux density at the Earth surface per HAPS platform station in dB(W/m²/500MHz);

10 that *resolves* *8* and *9* applies at any radio astronomy station that was in operation prior to 22 November 2019 and has been notified to the Bureau in the band 31.3-31.8 GHz before 22 May 2020; and that radio astronomy stations notified after this date may seek an agreement with administrations that have authorized HAPS,

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution.

**Reasons:** To add the text of a resolution specifying the operating requirements for HAPS to protect other services.

# 5. PROPOSALS FOR THE 38 - 39.5 GHZ BAND

### MOD USA/1.14/21

ARTICLE 5

**Frequency allocations**

**Section IV – Table of Frequency Allocations**(See No. **2.1**)

**38-39.5 GHz**

|  |  |  |
| --- | --- | --- |
| **Allocation to services** | | |
| **Region 1** | **Region 2** | **Region 3** |
| **38-39.5** FIXED ADD 5.G114  FIXED-SATELLITE (space-to-Earth)  MOBILE  Earth exploration-satellite (space-to-Earth)  5.547 | | |

**Reasons:** To add a footnote to the fixed service allocation in support of a worldwide HAPS designation in the 38-39.5 GHz band.

### ADD USA/1.14/22

**5.G114** The allocation to the fixed service in the band 38-39.5 GHz is designated for worldwide use by high-altitude platform stations (HAPS). This designation does not preclude the use of this frequency band by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. Such use of the fixed-service allocation by HAPS is limited to the ground-to-HAPS direction.

**Reasons:** To add the text of the footnote allowing HAPS to operate in the fixed service allocation in the 38-39.5 GHz band on a worldwide basis.

## Draft new Resolution for the 38-39.5 GHz band

### ADD USA/1.14/23

DRAFT NEW RESOLUTION [G114]

**Use of the frequency range 38-39.5 GHz by fixed links for high altitude   
platform stations in the fixed service worldwide**

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

*considering*

*a)* that WRC-15 considered that there is a need for greater broadband connectivity in underserved communities and in rural and remote areas, that current technologies can be used to deliver broadband applications by high-altitude platform stations (HAPS), which can provide broadband connectivity and disaster recovery communications with minimal ground network infrastructure;

*b)* that WRC-15 decided to study additional spectrum needs for fixed HAPS links to provide broadband connectivity, including within the band 38 – 39.5 GHz, recognizing that the existing HAPS designations were established without reference to today’s broadband capabilities;

*c)* that HAPS can provide broadband connectivity with minimal ground network infrastructure;

*d)* that Recommendation ITU-R P.618, “Propagation data and prediction methods required for the design of Earth-space telecommunication systems”, should be used to determine rain fade attenuation from HAPS platforms;

*e)* that Recommendation ITU-R P.452, “Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz”, should be used to determine the propagation loss in the ground path from HAPS ground stations;

*f)* that Recommendation ITU-R SF.1395, “Minimum propagation attenuation due to atmospheric gases for use in frequency sharing studies between the fixed-satellite service and the fixed service”, should be used to determine the gaseous attenuation;

*g)* that Recommendation ITU-R P.2108, “Prediction of Clutter Loss”, should be used to determine the clutter loss,

*Recognizing*

*a)* that the use of HAPS in this band is intended for the ground to HAPS direction;

*b)* that with respect to coordination procedures between neighboring administration for terrestrial services Article 9.18 of the Radio Regulations applies;

*Resolves*

1 that for the purpose of protecting terrestrial mobile service systems in neighboring administrations in the frequency range 38-39.5 GHz, the power flux density limit per HAPS ground station at the surface of the Earth in neighboring administrations shall not exceed the following pfd masks in dBW/m2/MHz under clear sky conditions without the explicit agreement from the affected administration:

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

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

Where:

*e.i.r.p.* nominal HAPS ground station EIRP density level in dBW/MHz (dependent to the elevation angle);

*d* distance between the HAPS ground station and the border of the neighboring administration (elevation angle dependent);

*Lpol* polarization discrimination of 3dB;

clutter loss (ITU-R P.2108);

propagation loss (ITU-R P.452);

2 that for the purpose of protecting FSS GSO and NGSO earth station systems in the fixed satellite service (space to-Earth) in neighboring administrations, coordination of a transmitting HAPS ground station is required when the power-flux density in dB(W/m²/MHz) at the border of an neighboring administration exceeds pfd limit of -111.3 dB(W/m²/MHz) for NGSO operations and -108.9 dB(W/m²/MHz) for GSO operations and the pfd values shall be verified considering a percentage of time of 20% in the relevant propagation model.

To verify the that pfd produced by HAPS ground station does not exceed the proposed pfd limits, the following equation was used:

Where:

nominal HAPS ground station EIRP density level in dBW/MHz towards the horizon;

*d* distance between the HAPS ground station and the FSS earth station;

propagation loss (ITU-R P.452);

instructs the Director of the Radiocommunication Bureau

to take all necessary measures to implement this Resolution.

# 6. PROPOSALS FOR THE 47 GHZ BANDS

## For the 47.2-47.5 GHz Band

### MOD USA/1.14/23

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations  
(See No. 2.1)

40-47.5 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 47.2-47.5 FIXED  FIXED-SATELLITE (Earth-to-space) 5.552  MOBILE  MOD 5.552A | | |

**Reasons**: To modify footnote 5.552A to reference an updated Resolution 122 which addresses the current worldwide HAPS designation in the 47.2-47.5 GHz band.

## For the 47.9-48.2 GHz Band

### MOD USA/1.14/24

47.5-51.4 GHz

|  |  |  |
| --- | --- | --- |
| Allocation to services | | |
| Region 1 | Region 2 | Region 3 |
| 47.9-48.2 FIXED  FIXED-SATELLITE (Earth-to-space) 5.552  MOBILE  MOD 5.552A | | |

**Reasons**: To modify footnote 5.552A to reference an updated Resolution 122 which addresses the current worldwide HAPS designation in the 47.9-48.2 GHz band.

### MOD USA/1.14/25

5.552A The allocation to the fixed service in the bands 47.2-47.5 GHz and 47.9-48.2 GHz is designated for use by high altitude platform stations (HAPS). Such use of the fixed-service allocation by HAPS is limited to the ground-to-HAPS direction. 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-19)**.

**Reasons:** To modify footnote 5.552A to reflect an updated Resolution 122 with allowances for increases in EIRP density levels during periods of rain and to limit operation to the ground-to-HAPS direction

## Modification of Resolution 122 for the 47.2-47.5 GHz and 47.9-48.2 GHz bands

### MOD USA/1.14/26

RESOLUTION 122 (rev.WRC‑19)

Use of the bands 47.2-47.5 GHz and 47.9-48.2 GHz by high altitude platform stations in the fixed service and by other services

The World Radiocommunication Conference (Sharm el-Sheikh, 2019),

*considering*

*a)* that the band 47.2-50.2 GHz is allocated to the fixed, mobile and fixed-satellite services on a co-primary basis;

*b)* that WRC-97 made provision for operation of high altitude platform stations (HAPS), also known as stratospheric repeaters, within the fixed service in the bands 47.2-47.5 GHz and 47.9-48.2 GHz;

*c)* that establishing a stable technical and regulatory environment will promote the use of all co-primary services in the band 47.2-47.5 GHz and 47.9-48.2 GHz;

*d)* that systems using HAPS are in an advanced stage of development and some countries have notified such systems to ITU in the bands 47.2-47.5 GHz and 47.9-48.2 GHz;

*e)* that Recommendation ITU-R F.1500 contains the characteristics of systems in the fixed service using HAPS in the bands 47.2-47.5 GHz and 47.9-48.2 GHz;

*f)* that while the decision to deploy HAPS can be taken on a national basis, such deployment may affect neighboring administrations and operators of co-primary services;

*g)* that ITU-R has completed studies dealing with sharing between systems using HAPS in the fixed service and other types of systems in the fixed service in the bands 47.2-47.5 GHz and 47.9-48.2 GHz;

*h)* that ITU-R has completed studies on compatibility between HAPS systems in the 47.2-47.5 GHz and 47.9-48.2 GHz bands and the radio astronomy service in the 48.94-49.04 GHz band;

*i)* that No. **5.552** urges administrations to take all practicable steps to reserve fixed-satellite service (FSS) use of the band 47.2-49.2 GHz for feeder links for the broadcasting-satellite service (BSS) operating in the band 40.5-42.5 GHz, and that ITU-R studies indicate that HAPS in the fixed service may share with such feeder links;

*j)* that the technical characteristics of expected BSS feeder links and FSS gateway-type stations are similar;

*k)* that ITU-R has completed studies dealing with sharing between systems using HAPS in the fixed service and the fixed-satellite service,

*recognizing*

*a)* that, in the long term, the bands 47.2-47.5 GHz and 47.9-48.2 GHz are expected to be required for HAPS operations for gateway applications;

*b)* that Recommendation ITU-R SF.1843 provides information on the feasibility of HAPS systems in the fixed service sharing with the FSS;

*c)* that ITU-R studies on HAPS operation in the bands 47.2-47.5 GHz and 47.9-48.2 GHz allocated to the fixed service have concluded that, in order to share with FSS (Earth-to-space), the maximum uplink transmit e.i.r.p. density of HAPS ground terminals in the bands should, in clear-sky conditions, be 6.4 dB(W/MHz) for Urban Area Coverage (UAC), 22.57 dB(W/MHz) for Suburban Area Coverage (SAC) and 28 dB(W/MHz) for Rural Area Coverage (RAC), and that these values can be increased by up to 20 dB during periods of rain;

*e)* that ITU-R studies have established specific power flux-density values to be met at international borders to facilitate bilateral agreement on sharing conditions for HAPS with other types of fixed service systems in a neighboring country;

*f)* that FSS satellite networks and systems with earth station antenna diameters of 2.5 meters or larger operating as a gateway-type station are capable of sharing with ubiquitous HAPS terminals,

*resolves*

1 that to facilitate sharing with the FSS (Earth-to-space), the maximum transmit e.i.r.p. density of a ubiquitous HAPS ground terminal shall not exceed the following levels under clear-sky conditions:

6.4 dB(W/MHz) for UAC (30° < θ ≤ 90°)

22.57 dB(W/MHz) for SAC (15° < θ ≤ 30°)

28 dB(W/MHz) for RAC (5° < θ ≤ 15°)

where θ is the ground terminal elevation angle in degrees;

2 that the values in *resolves 1* can be increased, up to 20 dB, to compensate for rain fade provided that the pfd at the space station does not exceed the value that would result when transmitting with the levels in *resolves 1* in clear sky condition;

3 that the ground terminal antenna patterns of HAPS operating in the bands 47.2-47.5 GHz and 47.9-48.2 GHz shall meet the following antenna beam patterns:

*G*(ϕ) = *Gmax* − 2.5 × 10−3  for 0° < ϕ < ϕ*m*



*G*(ϕ) = 39 − 5 log (*D*/λ) − 25 log ϕ for ϕ*m* ≤ ϕ < 48°

*G*(ϕ) = −3 − 5 log (*D*/ λ) for 48° ≤ ϕ ≤ 180°

where:

*Gmax* :maximum antenna gain (dBi)

*G*(ϕ) :gain (dBi) relative to an isotropic antenna

ϕ : off-axis angle (degrees)

expressed in the same units



degrees



*G* : gain of the first side lobe

2  15 log (*D*/) (dBi);

4 that for the purpose of protecting fixed wireless systems in neighboring administrations from co‑channel interference, a HAPS system operating in the frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz shall not exceed the following power flux-density values at the Earth’s surface at an administration’s border, unless explicit agreement of the affected administration is provided at the time of the notification of HAPS:

−141 dB(W/(m2 · MHz)) for  0° ≤ δ < 3°

−141 + 2(δ − 3) dB(W/( m2 · MHz)) for  3° ≤ δ ≤ 13°

−121 dB(W/( m2 · MHz)) for 13° < δ ≤ 90°

where  is the angle of the arrival above the horizontal plane in degrees;

6 that administrations planning to implement a HAPS system in the 47.2-47.5 GHz and 47.9-48.2 GHz bands shall notify the frequency assignments by submitting all mandatory elements of Appendix **4** to the Bureau for the examination of compliance with respect to *resolves*1, 2, 3, 4 and 5 above with a view to their registration in the Master International Frequency Register;

7 that administrations shall notify the new data elements for the notices referred to in *instructs the Director of the Radiocommunication Bureau* 1 in order to enable the Bureau to perform the examinations,

*invites administrations*

that intend to deploy HAPS systems in the fixed service in the bands 47.2-47.5GHz and 47.9-48.2 GHz to consider specifying the use of the bands 47.2-47.35 GHz and 47.9-48.05 GHz for ubiquitous HAPS terminals,

*instructs the Director of the Radiocommunication Bureau*

to examine all assignments to HAPS in the fixed service notified prior to 1 January 2020 and apply the provisions of *resolves* 1, 2, 3, 4 and 5 and the respective calculation methodologies included in Recommendation ITU-R F.1820 and Recommendation ITU-R SF.1843.

**Reasons:** To modify the existing Resolution 122 which supports a worldwide designation to HAPS to allow for increases in EIRP density levels during periods of rain.