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| Unmanned aircraft systems: the case for action at WRC‑15 | |
| Agenda item 1.5 | |

The fundamental purpose of WRC‑15 agenda item 1.5 is to consider how the frequency bands allocated to the fixed-satellite service (FSS) not subject to Appendices 30, 30A and 30B can be used for the control and non-payload communications (CNPC) of unmanned aircraft systems (UAS). Actions to support this agenda item have taken place both within ITU‑R WP 5B and the International Civil Aviation Organization (ICAO), with distinct roles in support of UAS.

ITU will address, via the Radio Regulations, the necessary provisions to ensure a regulatory framework to preclude harmful interference and protect incumbent services. ICAO will address, via their Standards and Recommended Practices (SARPs), the necessary technical and operational requirements to ensure safety of flight.

WRC‑15 has only two options: Develop a framework for the safe use of the FSS or do nothing (no change) and delay development of a vital, multi-billion dollar industry. As noted by ICAO, no change “would not be desirable in principle, because it would not fully address the existing requirements for beyond-line of sight communications for UAS and would potentially delay the development of civil UAS applications by many years.” It is critical that WRC‑15 adopt spectrum and regulatory provisions now to enable command and control of UAS and extend the benefits of this new technology to all the world’s inhabitants.

**Rising demand for unmanned aircraft:** The emergence of UAS for civil and commercial applications is among the most significant aviation advancements in decades. Applications for UAS include search and rescue, weather forecasting, firefighting, disaster response, precision farming, aerial photography, delivery of materials, and infrastructure and border monitoring, to name a few. The potential for this industry to contribute to the economic growth and wellbeing of developed and developing countries alike is tremendous.

**The FSS is suitable and available:** Access to the extensive capacity of global FSS networks provides an immediate solution to an urgent need. Completed studies substantiate that the preferred method for resolving agenda item 1.5 is to identify the current FSS allocations in the 20/30 GHz and 11/14 GHz for the CNPC of UAS. The existing FSS allocations are sufficient for this purpose – all that is needed is a resolution to define the necessary regulatory provisions.

Because UAS earth stations will operate within the same envelope as other earth stations associated with the FSS network, freedom from harmful interference is assured through existing coordination mechanisms.

**Studies necessary to support a WRC‑15 decision are completed:** The “*necessary studies leading to technical, regulatory, and operational recommendations to the Conference, enabling that Conference to decide on the use of FSS for CNPC links for operational UAS*” as specified in “invites ITU‑R 1” of Resolution 153 (WRC‑12) have been conducted and are available in ITU‑R [Document 5B/886 Rev.2](http://www.itu.int/md/R12-WP5B-C-0886/en) – “DRAFT NEW REPORT ITU‑R M.[UAS-FSS]”.

Annex 1 provides a summary of this report.

**ICAO position points the way for ITU action:** Action at WRC‑15 on a regulatory framework that provides ICAO the requisite “international recognition along with the basis for avoiding harmful interference” is paramount. The provisions for UAS CNPC communications links to meet the necessary technical and operational requirements for any specific airspace in any particular frequency band will be addressed within ICAO.

**CITEL’s Inter-American Proposal consistent with the ICAO Position:** The [CITEL IAP](https://www.itu.int/md/dologin_md.asp?lang=en&id=R15-WRC15-C-0007!A5!MSW-E) further evolves CPM Method A1, and was developed to address all of the ITU issues delineated by the [ICAO position](http://www.itu.int/md/R15-WRC15-C-0017/en), while maintaining “a firm focus on the critical safety of life elements” as emphasized by ICAO. This IAP approach is compatible with the ICAO position.

References

1) Annex 1 – Results of studies (<http://www.itu.int/md/R12-WP5B-C-0886/en>)

2) ICAO Position – WRC‑15 Document 17 (<http://www.itu.int/md/R15-WRC15-C-0017/en>)

3) CITEL IAP – WRC‑15 Document 7, Addendum 5 (<http://www.itu.int/md/R15-WRC15-C-0007/en>)

4) Information from ICAO on WRC‑15 Agenda Item 1.5 – WRC‑15 Document 67 (<http://www.itu.int/md/R15-WRC15-C-0067/en>)

Annex 1

WRC‑15 agenda item 1.5

Results of studies

The ITU‑R Document 5B/886 titled “DRAFT NEW REPORT ITU‑R M.[UAS-FSS]” contains all of the necessary studies conducted related to the “*Technical and operational characteristics, interference and regulatory environments associated with the use of frequency bands allocated to the fixed-satellite service not subject to Appendices 30, 30A and 30B for the control and non-payload communication of unmanned aircraft systems in non-segregated airspace” (referred to as “the Report*” in the remainder of this contribution) as requested in Resolution 153 associated with agenda item 1.5 (WRC‑15).

No other studies were conducted or submitted that refuted any of the assumptions, methodologies, approaches or conclusions contained in the Report.

Though completed, due to extraordinary circumstances, the Report was not approved through the normal ITU‑R process.

The document is posted on the ITU‑R WP5B website, under Doc. 5B/886 Rev.2. (TIES account needed); and is available at <http://www.itu.int/md/R12-WP5B-C-0886/en>.

The Report includes conducted studies which:

1) Use characteristics coordinated with the appropriate ITU‑R expert groups.

2) Show that earth stations on unmanned aircraft (UA) can meet the existing fixed-satellite service (FSS) performance requirements and will not impact existing FSS coordination.

3) Calculate a power flux-density (PFD) limit for the UA earth station transmissions to protect incumbent fixed service (FS) systems from interference.

4) Show that earth station receivers on the UA can successfully operate without placing constraints on incumbent systems.

5) Provide the International Civil Aviation Organization (ICAO) requested “basis for avoiding harmful interference” that it can use to define the technical and operational requirements for UAS.

6) Show that the use of the frequency bands allocated to the FSS, not subject to Appendices 30, 30A and 30B, can from a spectrum perspective; be considered to provide the reliable communication that will be necessary to provide for safe operation of UAS.

It is expected that all other aspects of using airspace with UA need to be defined by ICAO and other aviation standardization organizations (e.g. EUROCAE and RTCA). National civil aviation authorities’ requirements need to also be met to achieve certification for the operation of UAS.

Assumptions for the studies

It was a fundamental assumption made throughout the development of the Report that to use the frequency bands allocated to the FSS the UAS CNPC link carried over the space station must operate within the same regulatory and performance limitations as any other FSS earth or space station and that, from an interference perspective, it must perform its function in exactly the same manner as any other FSS earth or space station. This meant that, when compared to a non-UAS FSS system, the UA or the space station supporting the UA must neither cause additional interference to other incumbent services nor require additional protection from other incumbent services. Such incumbent services include the FS and other co-frequency FSS networks.

Furthermore, it should be noted that successful coordination of assignments in the frequency coordination process is a fundamental prerequisite for UA CNPC operation. Such coordination ensures that FSS network interference levels are never higher than those that would occur under the maximum transmit levels allowed by Article 21 and maximum off-axis effective isotropic radiated power (e.i.r.p.) levels allowed in ITU‑R S.524. Consequently by using these levels the Report addresses the very worst case intra-FSS network compatibility analyses.

The frequency bands allocated to the FSS, not subject to Appendices 30, 30A and 30B, have been supporting a multitude of UAS applications, including operating CNPC links, in segregated airspace for several decades. To date, these UAS CNPC links, operating under No. 4.4 of the Radio Regulations, have been supported with no complications due, for example, to interference or the impact of rain on the links. As these FSS bands currently support UAS CNPC, it is necessary to utilize the globally harmonized portions of these bands to prevent the need to add additional and potentially impractical amounts of radio equipment on board the UA.

UAS operating today are very sophisticated and with over two decades and many millions of operational flight hours of experience their designs have been refined so that they do not become unsafe if the CNPC link is disturbed and they can successfully and automatically land even if the CNPC link is lost.

Technical results

The following technical results are based on the analyses conducted in the Report:

1) The frequency bands allocated to FSS can be used for CNPC links for the operation of UAS under the technical, operational, and regulatory conditions given in the Report.

2) Adequate link margins, to accommodate possible interference and atmospheric/rain impairments can be provided under the condition that earth stations operating on board the UA, and their supporting space stations, use characteristics in line with the current FSS technical environment and relevant provisions of the Radio Regulations. Analysis was performed under the worst-case rain conditions on the links from the earth station (on the ground) to the satellite. Additional mitigation techniques are provided in the Report.

3) The earth station on board the UA, even when operating under the worst conditions on the ground, will still receive sufficient carrier to noise plus interference ratio (*C*/*N*+ *I*) for the wanted CNPC link (based on the link budgets in the Report) even when receiving interference from the four adjacent satellites (transmitting the maximum power identified in Article 21) on both sides of the one supporting the UAS.

4) The interference from earth stations of non-participating adjacent satellite systems cause a *C*/*N*+ *I* degradation towards the space station supporting the UA CNPC link of 0.2 dB maximum. This *C*/*N*+ *I* degradation is significantly less than the 1 dB *C*/*N*+ *I* degradation already included in the link budget calculations for the UA to satellite links included in the Report. Hence no harmful interference into space stations supporting UAS CNPC is expected.

5) No analysis of interference into other non-participating earth or space stations was performed based on the fundamental assumption stated in the Report that UAS-FSS systems will operate under the same constraints as any other FSS, and so will not cause any more interference than any non-UAS FSS earth or space station. The Report notes that ICAO, other standards bodies and the designers of the earth stations on board UA will have to take care to ensure compliance with ITU‑R S.524, in particular during aircraft maneouvering, so that the off-axis e.i.r.p. density levels stated therein are never exceeded.

6) Because of the fundamental assumption made in the Report that UA cannot ask for any reduction in interference from other services already operating in bands allocated to FSS then the Report proposes that UA will have to compensate, through design and mitigations, for any additional interference they receive when they fly near other incumbent services. The Report provides ICAO, other standards bodies and UAS designers with information on the levels of interference and their temporal characteristics that earth stations on board UA will receive during flight. The Report states that it must be those organizations, not ITU‑R, who determines how the levels of interference identified in the Report can be accommodated to ensure safe and efficient UAS operation. The Report also notes that ICAO, other standards bodies and the designers of the earth station on board the UA should not develop requirements that will force additional constraints on those incumbent services that operate in bands allocated to the FSS when those FSS support UAS CNPC operation.

7) The FS, sharing the frequency bands allocate to the FSS, will not receive interference from earth stations on board UA that exceed their short and long-term protection levels identified in ITU‑R F.758, ITU‑R F.1494 and ITU‑R F.1495 when the UA operates at latitudes less than 70 degree and above 5 000 ft in the 14-14.47 GHz band and above 3 000 ft in the 27.5-29.5 GHz band. These results are only applicable for earth stations on UA with antennas larger than 0.45 m. In addition the Report provides PFD versus elevation angles above the FS local horizon that earth stations operating on UA must comply with to meet acceptable levels of interference into the incumbent FS.

Operational results relative to UAS standards

The following operational results are based on the analyses conducted in the Report that will need to be captured in appropriate UAS standards.

1) UAS CNPC must comply with Article 21 and ITU‑R S.524 even when the aircraft is maneouvering.

2) Operation of UAS shall not force additional constraints on incumbent services, including co-frequency FSS.

3) Earth stations on UA shall not use antennas smaller in diameter than 0.45 m.

4) UA shall not operate at latitudes above 70 degrees.

5) UA shall not operate on frequencies in the band 14.00 to 14.47 GHz at altitudes below 5 000 ft.

6) UA shall not operate on frequencies in the band 27.5-29.5 GHz at altitudes below 3 000 ft.

7) Earth stations on UA shall comply with the two band-specific PFD masks described in the Report.

The Report provides significant technical detail to substantiate that the preferred method for resolving agenda item 1.5 is for the ITU to agree to globally allocate the FSS allocations in the 20/30 GHz and 11/14 GHz for the application of Control and Non-Payload Communications of Unmanned Aircraft Systems.

ICAO representatives have stated that the [CITEL Inter-American Proposal](https://www.itu.int/md/dologin_md.asp?lang=en&id=R15-WRC15-C-0007!A5!MSW-E) (available at <http://www.itu.int/md/R15-WRC15-C-0007/en>), which uses the Report and Method A1 of the Conference Preparatory Meeting (CPM) report as its basis, is fully compatible with the ICAO Position on WRC‑15 agenda item 1.5. So recognizing that the introduction of UA into non-segregated airspace will, from a spectrum perspective, maintain the continued safety of other airspace users as well as life and property on the ground.

FSS operators have also indicated that the technical, regulatory and operational concepts and requirements derived in the UAS-FSS Report, will not compromise their coordination activities.

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