IWG-3/36R1 (12/20/2013)

Authors: D. Jansky (SES)

M. Neale (GA-ASI) J. Nelsen(SES)

A. Ours (Intelsat)

2015 WORLD RADIOCOMMUNICATION CONFERENCE

DRAFT PROPOSALS FOR THE WORK OF THE CONFERENCE

AGENDA ITEM 1.5: to consider 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 communications of unmanned aircraft systems (UAS) in non-segmented airspace in accordance with Resolution 153 (WRC-12).

BACKGROUND: This agenda item is to support the addition of technical and regulatory provisions to enable use of portions of bands allocated to the fixed satellite service (FSS) for unmanned aircraft system (UAS) control and non-payload communications (CNPC) links in non-segregated airspace, if studies demonstrate compatibility with incumbent services and that the requirements of aviation authorities are satisfied without supporting the addition of an aeronautical mobile satellite (route) service (AMS(R)S) allocation to the FSS bands used for this purpose.

In the context of this agenda item, a UAS consists of an unmanned aircraft (UA) with an Earth station on-board to interconnect the UA and the associated unmannered aircraft control station (UACS) with its own Earth station through a satellite operating in the FSS. UA are aircraft that do not carry a human pilot but that are piloted remotely, i.e. through a reliable communication link (CNPC) from outside the aircraft. UAS operations up to now have been limited to segregated airspace. However, it is planned to expand UAS deployment outside of segregated airspace.

The development of UAS is based on recent technological advances in aviation, electronics and structural materials, making the economics of UAS operations more favorable, particularly for more repetitive, routine and long-haul duration applications. The current state of the art in UAS design and operation, is leading to the rapid development of UAS applications to fill many diverse requirements. There are a large variety of existing and envisioned applications of UAS in the fields of economy, public safety and science. Further details on UAS applications in non-segregated airspace can be found in Report ITU-R M.2171. The operation of UA outside segregated airspace requires addressing the same issues as manned aircraft, namely safe and efficient integration into the air traffic control system.

A huge number of satellite communication networks operate on frequency bands allocated to the FSS. Report ITU-R M.2171 identifies a large variety of prospects for remotely piloted (Unmanned) aircraft that would need to fly long-distances (worldwide) through airspaces

controlled by civil air traffic control (ATC). Immediate access to this globally existing capacity would provide great advantages for UA fleet operators fostering new applications, enabling faster developments of new markets, while providing planning stability for significant investments. Studies under this agenda item investigated the link feasibilities and sharing conditions for using CNPC over typical frequency spectrum allocated in several FSS allocations under which such applications could be authorized.

Report ITU-R M.2233 contains examples of technical characteristics for UA CNPC including FSS systems operating in portions of the frequency ranges 10.95-14.5 GHz and 17.3-30.0 GHz. These examples indicated that it may be possible to operate UAS CNPC links in these bands while meeting the desired link performance. It is recognized that a further Report may be available by the time of WRC-15.

The proposal found below sets forth the basis for accomplishing this objective. It includes text for a footnote to the appropriate FSS bands which points to a Resolution that spells out the conditions of use for supporting safe and efficient operation of UAS.

Proposal:

USA/1.5/1

ADD

ARTICLE 5

Frequency allocations

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

10-11.7 GHz

Allocation to services		
Region 1	Region 2	Region 3
10.7-11.7	10.7-11.7	
FIXED	FIXED	
FIXED-SATELLITE (space-to-Earth) 5.441 5.484A 5.XXX (Earth-to-space) 5.484	FIXED-SATELLITE (space-to-Earth) 5.441 5.484A 5.XXX MOBILE except aeronautical mobile	
MOBILE except aeronautical mobile		

11.7-14 GHz

Allocation to services			
Region 1	Region 2	Region 3	
11.7-12.5 FIXED MOBILE except aeronautica mobile BROADCASTING BROADCASTING-SATELI 5.492	(space-to-Earth) 5.484A 5.488 <u>5.XXX</u>	11.7-12.2 FIXED MOBILE except aeronautical mobile BROADCASTING BROADCASTING-SATELLITE 5.492	
	12.1-12.2 FIXED-SATELLITE (space-to-Earth) 5.484A 5.488 5.XXX 5.485 5.489	5.487 5.487A	
	12.2-12.7 FIXED MOBILE except aeronautical mobile BROADCASTING BROADCASTING-SATELLITE 5.492	12.2-12.5 FIXED FIXED-SATELLITE (space-to-Earth) 5.XXX MOBILE except aeronautical mobile BROADCASTING	
5.487 5.487A	3.472	5.484A 5.487	
12.5-12.75	5.487A 5.488 5.490	12.5-12.75	
FIXED-SATELLITE (space-to-Earth) 5.484A_5 (Earth-to-space)	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE except aeronautical mobile	FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.XXX MOBILE except aeronautical mobile BROADCASTING- SATELLITE 5.493	
5.494 5.495 5.496		5111222112 01.90	
13.75-14	RADIOLOCATION Earth exploration-satellite	Earth exploration-satellite Standard frequency and time signal-satellite (Earth-to-space) Space research	

14-14.5 GHz

Allocation to services			
Region 1	Region 2 Region 3		
14-14.25	FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B 5.XXX RADIONAVIGATION 5.504 Mobile-satellite (Earth-to-space) 5.504B 5.504C 5.506A Space research 5.504A 5.505		
14.25-14.3	FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B 5.XXX RADIONAVIGATION 5.504 Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.508A Space research 5.504A 5.505 5.508		
14.3-14.4 FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B 5.XXX MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Radionavigation-satellite 5.504A	14.3-14.4 FIXED-SATELLITE (Earth-to-space) 5.457A 5.484A 5.506 5.506B 5.XXX Mobile-satellite (Earth-to-space) 5.506A Radionavigation-satellite	14.3-14.4 FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.484A 5.506 5.506B 5.XXX MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Radionavigation-satellite 5.504A	
14.4-14.47	FIXED FIXED-SATELLITE (Earth-to-space) 5.506 5.506B 5.XXX MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.50 Space research (space-to-Earth) 5.504A		
14.47-14.5	FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B 5.XXX MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Radio astronomy 5.149 5.504A		

17.3-18.4 GHz

Allocation to services		
Region 1	Region 2	Region 3
17.3-17.7 FIXED-SATELLITE (Earth-to-space) 5.516 (space-to-Earth) 5.516A 5.516B 5.XXX Radiolocation 5.514	17.3-17.7 FIXED-SATELLITE (Earth-to-space) 5.516 BROADCASTING-SATELLITE Radiolocation 5.514 5.515	17.3-17.7 FIXED-SATELLITE (Earth-to-space) 5.516 Radiolocation
17.7-18.1 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A (Earth-to-space) 5.516 MOBILE	17.7-17.8 FIXED FIXED-SATELLITE (space-to-Earth) 5.517 (Earth-to-space) 5.516 BROADCASTING-SATELLITE Mobile 5.515 17.8-18.1 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A (Earth-to-space) 5.516 MOBILE 5.519	17.7-18.1 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A (Earth-to-space) 5.516 MOBILE
18.1-18.4 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B 5.XXX (Earth-to-space) 5.520 MOBILE 5.519 5.521		

18.4-20.2 GHz

Allocation to services		
Region 1	Region 2	Region 3
18.4-18.6 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B 5.XXX MOBILE		
18.6-18.8 EARTH EXPLORATION- SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.522B 5.XXX MOBILE except aeronautical mobile Space research (passive)	18.6-18.8 EARTH EXPLORATION- SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.516B 5.522B 5.XXX MOBILE except aeronautical mobile SPACE RESEARCH (passive)	18.6-18.8 EARTH EXPLORATION- SATELLITE (passive) FIXED FIXED-SATELLITE (space-to-Earth) 5.522B 5.XXX MOBILE except aeronautical mobile Space research (passive)
5.522A 5.522C	5.522A	5.522A
19.7-20.1 FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B 5.XXX Mobile-satellite (space-to-Earth)	19.7-20.1 FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B 5.XXX MOBILE-SATELLITE (space-to-Earth) 5.524 5.525 5.526 5.527 5.528	19.7-20.1 FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B 5.XXX Mobile-satellite (space-to-Earth)
5.524	5.529	5.524
20.1-20.2 FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B <u>5.XXX</u> MOBILE-SATELLITE (space-to-Earth) 5.524 5.525 5.526 5.527 5.528		

27.5-29.9 GHz

Allocation to services		
Region 1	Region 2	Region 3
	FIXED 5.537A FIXED-SATELLITE (Earth-to-space) MOBILE 5.538 5.540	5.484A 5.516B 5.539 <u>5.XXX</u>
	FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.523A 5.539 5.XXX MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540	
	FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.523A 5.539 MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540	
29.5-29.9 FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 5.XXX	29.5-29.9 FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 5.XXX	29.5-29.9 FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 5.XXX
Earth exploration-satellite (Earth-to-space) 5.541	MOBILE-SATELLITE (Earth-to-space)	Earth exploration-satellite (Earth-to-space) 5.541
Mobile-satellite (Earth-to-space)	Earth exploration-satellite (Earth-to-space) 5.541	Mobile-satellite (Earth-to-space)
5.540 5.542	5.525 5.526 5.527 5.529 5.540 5.542	5.540 5.542

29.9-30 GHz

Allocation to services			
Region 1 Region 2 Region 3			
29.9-30 FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 <u>5.XXX</u>			
MOBILE-SATELLITE (Earth-to-space)			
Earth exploration-satellite (Earth-to-space) 5.541 5.543			
5.525 5.526 5.527 5.538 5.540 5.542			

Reasons: To provide a footnote allowing the use of UAS CNPC links in the fixed-satellite service not subject to Appendices 30, 30A and 30B.

USA/1.5/2

ADD

5.XXX This band may also be used for the control and non-payload communication (CNPC) of unmanned aircraft systems. Such systems shall be operated under provisions of Resolution [FSS-UA-CNPC] (WRC-15).

USA/1.5/3

ADD

DRAFT RESOLUTION [FSS-UA-CNPC] (WRC-15)

Provision related to Earth stations on board unmanned aircraft which operate with geostationary satellites in the fixed-satellite service for the control and non-payload communications (CNPC) of unmanned aircraft systems in non-segregated airspaces

The World Radiocommunication Conference (Geneva, 2015),

considering,

- a) that there is a demand for the control of unmanned aircraft systems (UAS) via satellite communication networks while operating in non-segregated airspace;
- b) that worldwide use of unmanned aircraft systems (UAS) is expected to increase significantly in the near future;
- c) that unmanned aircraft (UA) need to operate seamlessly with piloted aircraft in non-segregated airspace and that there is a need to provide global harmonized spectrum for that purpose;
- d) that the operation of UAS in non-segregated airspace requires reliable communication links, in particular to relay the air traffic control communications and for the remote pilot to control the flight;

- e) that, in accordance with the Convention on International Civil Aviation, all aeronautical systems must meet standards and recommended practices (SARPs);
- f) that SARPs are applicable to the use of frequency spectrum to support the safe operation of aeronautical systems;
- g) that satellite radiocommunications are an essential part of UAS operations, in particular to relay transmissions beyond the horizon and include links between the unmanned aircraft and the satellite, and links between the UA Control Station (UACS) and the satellite;
- h) that appropriate Article 11 notification status of a FSS network is a pre-requisite for the use of FSS space system (channel) for UA CNPC links;

considering further

- a) that there is a need to limit the number of communication equipments onboard a UA;
- b) that, as a dedicated satellite system for UAS is not likely, it is necessary to take into account the existing and future satellite systems to accommodate the growth of the use of UAS;
- c) that there are various technical methods that may be used to increase the reliability of digital communication links, e.g. modulation, coding, redundancy, etc. that can be used to ensure safe operations of UAS in non-segregated air space;
- d) that for UAS communications used for the control of UA, relay of air traffic control voice communications, and sense and avoid, relate to the safe operation of UAS and have certain technical, operational, and regulatory requirements;
- e) that the requirements in *considering further d*) can be specified for UAS use of FSS networks.

recognizing

- a) that Report ITU-R M.2171 provides information on the vast number of applications for Unmanned Aircraft needing access to non-segregated airspaces;
- b) that Recommendation 724 (WRC-07) notes that FSS is not, intrinsically, a safety service;
- c) that agenda item 1.5 calls for the safe operation of UAS in non-segregated air space, resolves
- that UA control and non-payload communication shall operate under the regulatory and operational provisions contained in Annex 1;

- that the use of such links shall be operated in accordance with procedures established by the International Civil Aviation Organization (ICAO),
- 3. that a fixed satellite service earth station on an unmanned aircraft shall be defined as an earth station operating in the fixed satellite service,
- 4. that the provisions of this Resolution shall apply to FSS links in the indicated frequency bands being used for CNPC of UAS in non-segmented air space as indicated in the Figure 1 of Annex 2,
- 5. that the FSS stations operating in frequency bands supporting these CNPC links shall conform to the applicable technical provisions of the radio regulations,

encourages concerned administrations

1 to cooperate with administrations which license UA CNPC while seeking agreement under the abovementioned provisions,

instructs the Secretary-General

to bring this Resolution to the attention of the Secretary-General of the International Civil Aviation Organization (ICAO).

ANNEX 1 TO RESOLUTION [FSS-UA-CNPC] (WRC-15)

Regulatory and operational provisions for UA CNPC links operating through satellite systems operated in the FSS frequency bands

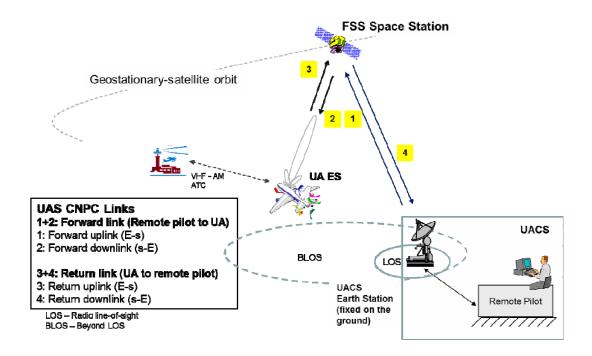
- 1 It is anticipated that ICAO will develop associated standards and recommended practices (SARPs), taking into account the above.
- 2 Conformity with the Radio Regulations is ensured by application of Articles **9** and **11**. In the course of this action, the BR always checks the consistency of any frequency assignment with the relevant technical and regulatory provisions contained in the RR, thus meeting the requirement in the ICAO conditions Any UAS CNPC link will operate under the protection provided by the registered FSS frequency assignments.
- 3 FSS frequencies used for UAS will use frequency assignments that are "successfully coordinated". Satellite operators and administrations are required to carry out coordination of their FSS frequency assignments in accordance with the provisions contained in Article 9 of the Radio Regulations. The application of such provisions ensures that FSS frequency assignments can operate free from harmful interference caused by and to other systems. The efficiency of those rules is proven by the fact that FSS frequency assignments have been successfully operated for many years.
- When the coordination process is completed, the BR will be notified (according to the provisions of RR Article 11) by the administration proposing the new system and the frequency assignments will be recorded in the MIFR. If a frequency assignment is recorded in the MIFR under RR 11.41, such an assignment is still entitled to protect and be protected against frequency assignments of other networks with which coordination has been successfully completed. The FSS operator then has to make sure that the outstanding coordination issues are examined to determine if UAS CNPC operations can take place within the ICAO requirements. This would be done for example by determining whether the affected network with which coordination has not been achieved is actually in operation and if so what the operational parameters are (e.g. orbital location and filed power levels) to ensure that any resultant impact would be acceptable.
- 5 Predicting interference risks, planning solutions for potential interference scenarios, adopting measures to solve the interference issues and reporting on the interference cases, are elements which are well known to FSS operators and which should be included in the specific agreements between FSS operators and UAS operators with guidance from Aviation Authorities (some of which could be included in SARPs).
- 6 Innovative ways to detect and prosecute the interference cases are being developed nowadays at international level, in order to gain further experience and contribute to harmonized and transparent reporting mechanisms of interference cases.
- The ITU and ICAO will carry out their mutual responsibilities in a cooperative manner. It is important that the respective roles of ICAO and the ITU be fully understood to ensure appropriate separation of regulatory needs to be addressed in the RR and operational issues to be addressed by ICAO processes. In this context, ITU will develop the typical conditions for operation of CNPC links, and then, ICAO will develop further operational conditions to ensure safe operation.

ANNEX 2 TO RESOLUTION [FSS-UA-CNPC] (WRC-15)

UA CNPC FSS Links

FIGURE 1

Typical BLOS CNPC links in an unmanned aircraft system



The forward and return (UAS) links via an FSS network