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AsiaSat

WRC-23 AGENDA ITEM 1.8

Controlling Unmanned Aircraft

Through Regular Commercial FSS Transponders

Good or bad idea?

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Unmanned, or more precisely - remotely piloted, aircraft are seeing an increasing interest and foreseen applications include cargo planes, crop dusters, surveillance planes, etc. Like any other airplane, the flight of such planes needs to be controlled in a safe and reliable manner. When flying within the reach of a control transmitter/receiver on the ground, control of the unmanned aircraft may be conducted through this station. However, there will be large areas where building a ground-based control network is not technically possible, e.g. over the oceans, or economically practical, e.g. for long-haul flights or flights over areas with low traffic density. For such cases, satellite links would be a logical choice.

Background

Use of satellite links to control unmanned aircraft has been debated for decades. As early as the International Telecommunication Union (ITU) World Radio Conference in 2007 (WRC-07), Resolution 421 was established calling for identification of spectrum for this purpose, including satellite spectrum. In accordance with this resolution, at WRC-12 under Agenda Item 1.3, spectrum for "aeronautical mobile-satellite (R)[1]" service was allocated in the 5 000-5 150 MHz band, about 3 times the specified spectrum requirements indicated in ITU-R Report M.2171.

However, things didn't stop with this.

Since it is not a frequency band for regular Fixed-Satellite Service (FSS) or Mobile-Satellite Service (MSS) applications, use of the 5 000-5 150 MHz band to control unmanned aircraft would require dedicated payloads to be built and incorporated into satellites. This would result in expensive solutions that could only be offered through a limited number of satellites.

A cheaper and simpler solution would be to use readily available regular transponders of commercial FSS satellites.

This issue was brought up at WRC-12 and was subsequently decided to be studied and discussed at the next Conference – WRC-15. Following a heated debate at WRC-15, it was decided that UAS CNPC links ("**U**nmanned **A**ircraft **S**ystem for **C**ontrol and **N**on-**P**ayload **C**ommunications" as is the terminology chosen within ITU) for unmanned aircraft operating in non-segregated airspace[2] could be offered on transponders of regular, commercial FSS geostationary satellites in the "unplanned"[3] portions of Ku-band (downlinks in the 10.95-11.2/11.45-11.7 GHz globally, 11.7-12.2 GHz in Region 2[4], 12.2-12.5 GHz in Region 3[4], 12.5-12.75 GHz in Regions 1[4] and 3[4] bands and uplinks in the 14-14.47 GHz band) and "non-shared"[5] Ka-band (downlinks in the 19.7-20.2 GHz band and uplinks in the 29.5-30.0 GHz band). With the exception of C-band, this constitutes most of the "unplanned" frequency bands commonly used by commercial FSS satellites.

However, WRC-15 was unable to work out detailed regulatory and technical conditions for UAS CNPC operation and decided that ITU would work on such and consider these at WRC-23. Until such provisions have been adopted by WRC-23, ITU has been instructed not to process any submissions for UAS CNPC links. Currently, this topic is being studied in preparation for WRC-23 under its Agenda Item 1.8.

WRC-15 also recognized that while the spectrum use of UAS CNPC links lies within the authority and responsibility of ITU, the responsibility in respect of the safety of flight aspects lies within ICAO (the International Civil Aviation Organization). This requires that the work of the two organizations is coordinated to develop and adopt provisions which cover all aspects of UAS CNPC operation in a satisfactory and complementary manner while not contradicting with those of each other. However, it is a task easier said than done in the case of two international organizations, working independently, at their individual pace and with decisions made by consensus of their respective Member States according to their individual objectives and with different governmental bodies representing the country in the two organizations.

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[1] An aeronautical mobile-satellite service reserved for communications relating to safety and regularity of flights, primarily along national or international civil air routes.

[2] Segregated airspace is airspace which is reserved for specific users. Non-segregated airspace is everywhere else.

[3] "Unplanned" is referring to the frequency bands not subject to the space plans contained in Appendix 30, 30A or 30B of the Radio Regulations.

[4] ITU-R Region 1 constitutes Africa, Middle East, Europe, Mongolia and the RCC countries, Region 2 constitutes the Americas and Region 3 comprises Asia east of and including Iran, and most of Oceania.

[5] "Non-shared" is referring to frequency bands allocated to FSS, but not to any terrestrial services and where there are no limitations on FSS to protect terrestrial services.

So what is a UAS CNPC system? As the name implies, this is a system to control the flight of the aircraft, not to operate a payload on-board the aircraft, download data or for other operations which are not related to the maneuvering itself. The below figure shows the architecture of a UAS CNPC system.

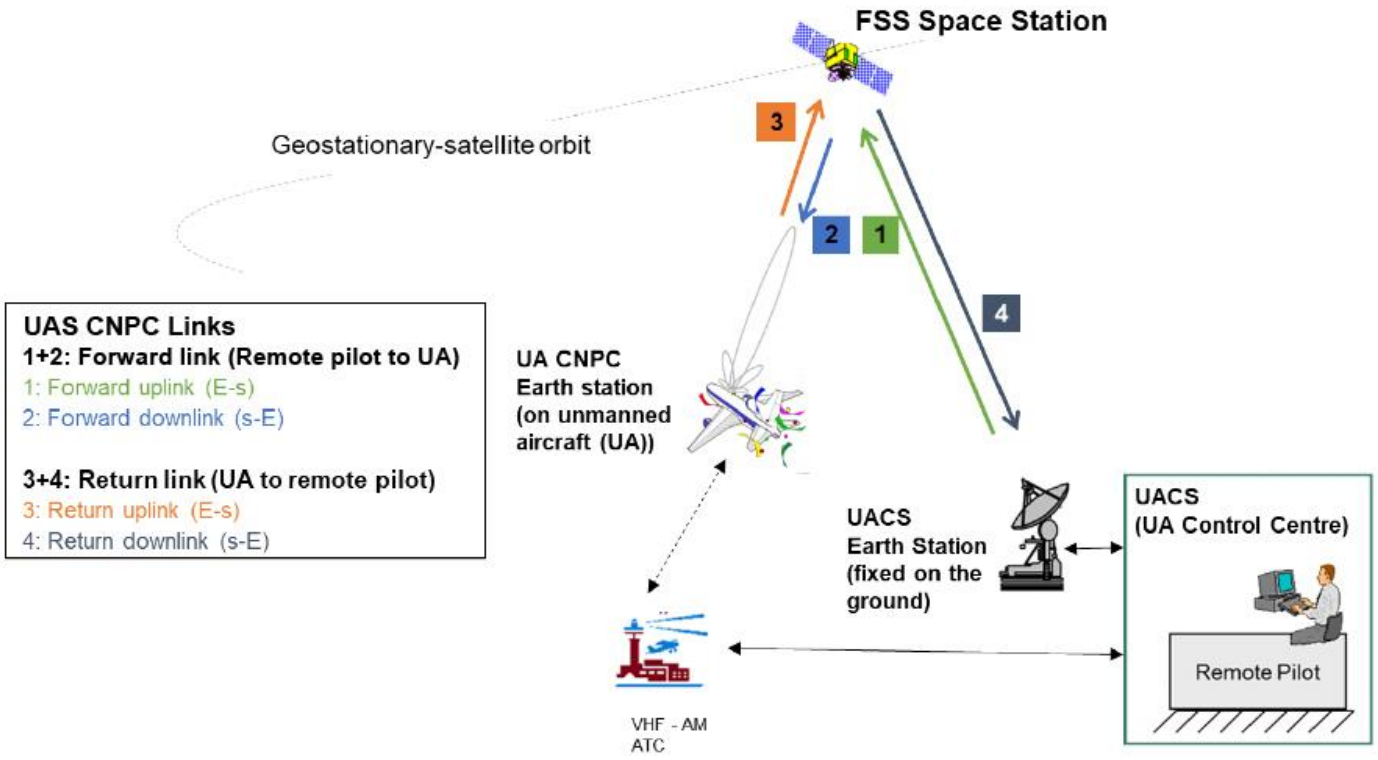

Figure: UAS CNPC architecture

Questions

Actually, transponders of regular FSS satellites are being used to control some special types of unmanned aircraft today and have been so for several years, but then without any international recognition or regulatory provisions and possibly without the same requirements in respect of safety of flight. Questions arise when considering a widespread and general use of such applications, with regulatory provisions and international recognition.

- Are the most used and most congested commercial FSS bands suitable for an application to safely control the flight of unmanned aircraft?
- What would be the impact on other regular FSS applications using these frequency bands by the introduction of such a new application into the Radio Regulations?
- Would it be possible to ensure compatibility with terrestrial services sharing the frequency bands while ensuring the capability to safely control the flight of the unmanned aircraft in a predictable manner?

Safe control of flight

Together with C-band, the bands identified by WRC-15 for UAS CNPC operation are the most heavily used and congested FSS frequency bands. A large number of satellites with a varying degree of completion of the ITU required frequency coordination are offering commercial services to a multitude of service providers, including VSAT with transmitting earth stations on customer premises, SNG and nomadic terminals. As a result of the congestion and the multitude of regular FSS applications in these frequency bands, accidental interference into other satellite links will occur from time to time, from mispointed antennas, malfunctioning equipment, transmissions on wrong frequency or polarization, terminals transmitting above their contractual EIRP limits, etc. In less congested bands and in particular in dedicated bands for this kind of application like the 5 000- 5 150 MHz band, the risk of encountering interference would be significantly lower. Noting that ICAO is responsible for the safety of flight, in particular for ICAO, the question then is if picking two of the most heavily congested frequency bands, for the sake of getting cheap and readily available satellite capacity, is the right choice for a service that requires to ensure the safe control of flight.

Impact on regular FSS

As has been recognized over a few decades now, due to the spectrum orbital resources being a limited resource, there is a huge congestion in the key FSS frequency bands, including the bands identified by WRC-15 for UAS CNPC. The ITU Radio Regulations use very conservative "coordination triggers", i.e. criteria for when an administration seeking to introduce a new satellite network needs to seek the agreement of other administrations during the coordination process[6]. To develop new satellite networks, administrations and satellite operators during this coordination process negotiate conditions whereupon existing satellite networks tolerate interference from the planned new satellite network while still being able to meet its performance objectives. These agreed interference levels are normally much higher than the ITU coordination triggers.

During the discussions in ITU, there is agreement that UAS CNPC in the commercial FSS bands should not have any higher status than regular FSS and should not seek any additional protection. However, due to the requirements for safety of flight, there is a great concern that UAS CNPC operation, while still within the same ITU coordination triggers could tolerate less interference than that of regular FSS in practical coordination. Noting that most FSS networks are operated on commercial terms, in competition with other commercial satellite networks, there is also the concern that during the coordination process UAS CNPC operation or plans for such could be used as an excuse to seek more protection or block new, competing FSS networks. This could severely limit the capability to further develop FSS operation and deploy new satellite networks.

It is also noted that the responsibility for safety of flight lies within ICAO and they are developing their own procedures for this purpose. These procedures address much more than just the spectrum access, such as training and qualifications of remote pilots at control centres, assessment and approval of airworthiness, redundancy of equipment and links, preprogrammed response in the case of loss of link, handover procedures when switching from one satellite to another, etc. However, these procedures could also address spectrum access and availability and interference protection of the link and there are concerns that in this respect, there could be contradiction between the principles agreed in ITU and

[6] In ITU, only countries obtain frequency rights and frequency coordination in ITU terms is a process between frequency administrations of countries. Administrations may authorize satellite operators to use specific satellite networks. Satellite operators often discuss and reach operational agreements with other satellite operators using adjacent satellite networks and satellite operators also often support the frequency administrations in their frequency coordination, but ITU only recognizes frequency administrations in this respect.

those agreed in ICAO and that the principles and procedures agreed by ICAO, irrespective of what regulatory provisions ITU might adopt, could have an adverse impact on the development and deployment of new FSS networks.

Relationship with terrestrial services

At Ku-band, the unplanned FSS frequency bands identified for UAS CNPC to a large extent also have ITU allocations for terrestrial services, mobile and/or fixed. Compatibility between stations of terrestrial services and the FSS spacecraft as well as the UACS Earth station (ground control station) is obtained through the regular FSS coordination. However, without due consideration, transmitting stations of terrestrial services could cause interference to receiving Earth stations on-board unmanned aircraft and transmitting Earth stations on-board unmanned aircraft could cause interference to receiving stations of terrestrial services.

Compatibility between FSS earth stations and terrestrial services is established through a coordination procedure where the specific location of the earth station is located. However, for earth stations mounted on an aircraft, these necessarily will not remain at one location and questions have been raised as to how to ensure this compatibility.

Through discussions at the ITU, it has been agreed that use of FSS transponders for UAS CNPC links should not hinder current or future use of the bands by terrestrial services any more than what regular FSS would do.

For the interference from terrestrial transmitters into the receiving earth stations on-board the unmanned aircraft, the principle solution identified is through requiring earth stations on-board the unmanned aircraft to accept the interference levels encountered by current and future terrestrial transmitters when operating in that area. While this may be agreeable to ITU, one pertinent question would be if this would be equally acceptable to ICAO in respect of their need to ensure the safety of flight.

The transmitting earth stations on-board the unmanned aircraft could potentially create interference to receivers of terrestrial services. Two alternative solutions for this issue have been identified:

- One option is to identify limits on the signal levels produced on ground by the Earth stations. This would ensure a defined protection of terrestrial services and at the same time provide operational certainty for the UAS CNPC operator.

- The other option is to require that Earth stations on-board unmanned aircraft do not cause “unacceptable” interference to terrestrial services. This may sound fine. However, “unacceptable” in ITU terms is a non-quantified term which is referring to agreements between administrations and without a prior agreement, any administration can claim any level of interference, no matter how low, as “unacceptable” and any quantified level would only serve as a guidance that administrations can choose to recognize or not as they wish. Also administrations of countries far from where the unmanned aircraft is operating could claim the interference into their country to be “unacceptable” and demand that the emissions are switched off. As a result, there would be no operational certainty for the UAS CNPC operator in this case. What ICAO’s thoughts would be in respect of operating under such conditions while ensuring the safety of flight is not known.

What are the solutions?

In the ITU preparatory work, two solutions have been identified:

Method A

This method proposes to suppress the whole notion of UAS CNPC in the commercial FSS bands as some administrations believe that it will not be possible to achieve the objectives of safely controlling unmanned aircraft through FSS links while avoiding adverse impact on regular FSS and terrestrial services sharing these frequency bands. UAS CNPC operation through satellite links then would be conducted in the frequency bands identified specifically for safety operation.

Method B

This method aims at developing permanent provisions for the operation of UAS CNPC links as an application of FSS in the identified frequency bands. However, while some principles are agreed, there are also key issues that are yet unresolved and where there are diverging views on the solutions. This includes how to establish compatibility with terrestrial services and also how to, within ITU, address the safety of flight issues and identify responsibilities in this respect and in particular how to do this without adversely impacting other regular FSS networks or terrestrial services.

ITU is now in the process of wrapping up its preparatory work on the WRC-23 agenda items. In March/April 2023, the Conference Preparatory Meeting (CPM) will finalize the CPM Report for WRC-23, containing the results of all the ITU studies on the WRC-23 agenda items. Before the CPM meeting and between CPM and WRC-23 next November/December, countries will work through regional organizations such as Asia-Pacific Telecommunity (APT), European Conference of Postal and Telecommunications Administrations (CEPT), African Telecommunications Union (ATU), Inter-American Telecommunication Commission (CITEL), Regional Commonwealth in the Field of Communications (RCC) and Arab Spectrum Management Group (ASMG) and/or independently work to develop proposals for CPM as well as for WRC itself. However, failing to see solutions to Method B that are deemed satisfactory by administrations and regional organizations, administrations which in the outset could be supporting Method B are likely to turn towards supporting Method A.

Wrapping up

In the light of the issues associated with UAS CNPC operation in unplanned Ku- and Ka-band, questions are:

- Is UAS CNPC using regular FSS transponders to obtain cheap and readily available satellite capacity a good idea?
- Can regulatory provisions be contemplated under which UAS CNPC could operate satisfactorily without having an adverse impact on the development of regular FSS operation?
- How can ITU and WRC-23 be confident that ICAO will not impose conditions on UAS CNPC that would lead to difficulties for the development of regular FSS operation?
- Can solutions be worked out for co-existence with terrestrial services that offer reliable and predictable links for the control of the unmanned aircraft?
- Or was the idea of WRC-15 a bad idea and WRC-23 should scrap it?

The above questions may help us discover different ways of thinking about this issue, and help us come up with the right decisions in this respect as we discuss it with our frequency administrations, civil aviation authorities, regional telecommunications organizations, associations representing satellite interests and/or at ITU meetings to raise the awareness of this agenda item and become involved to contribute to achieving the best solution for the aviation industry, terrestrial services and regular FSS alike.

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About AsiaSat

AsiaSat offers reliable satellite connectivity, media and data solutions to customers in the broadcast, telecom and mobility sectors through its fleet of six in-orbit satellites – AsiaSat 4, AsiaSat 5, AsiaSat 6, AsiaSat 7, AsiaSat 8 and AsiaSat 9, and teleport infrastructure. From content distribution to headends, telcos, DTH, DTT platforms; Occasional Use; to One Click Go Live streaming service; IP-based, hybrid OTT service; hosting services; cutting edge VSAT solutions serving aviation, maritime, mobile backhaul, AsiaSat helps bridge the digital divide, aiming to be the foremost satellite solutions provider and an instinctive partner of choice in the Asia-Pacific.

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