Telemetry Spectrum Encroachment
Review of Related WRC-27 Agenda and Domestic Threats

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Abstract: A review of international and domestic spectrum issues that present challenges for the future use of radio frequency telemetry after the 2023 World Radiocommunications Conference (WRC-23). Several agenda items addressed there have a potential for telemetry spectrum encroachment and are presented in this paper. Agenda topics of telemetry interest in future World Radiocommunications Conferences (WRCs), in particular several agenda items that will be considered at the 2027 World Radiocommunications Conference (WRC-27), are a particular focus. International telemetry vendors, suppliers, and users need to be aware of, and potentially engage with, their national administrations on these items to protect and preserve spectrum for the future of aeronautical mobile telemetry.

Key words: Telemetry spectrum, frequency spectrum encroachment, Aeronautical Mobile Telemetry**.**

Telemetry Spectrum at Risk

Telemetry users around the world are facing a critical challenge -- how to address an increase in telemetry needs with greater global competition from many industry sectors for increased access to the same range of spectrum bands. Several factors have revolutionized demand for electromagnetic spectrum. These factors include:

- Very congested RF spectrum, especially in the communications bands below 7 GHz.
- Increasing demands by providers for more cellular and mobile broadband spectrum globally.
- Increasing real-time data needs to support the safe and effective flight testing of the global commercial aeronautical industry.

Telemetry users are caught between a proverbial rock (telemetry demand is increasing) and a hard place (telemetry spectrum is increasingly being considered for repurposing combined with a lack of alternatives for telemetry spectrum).

As an example, CTIA [1] (originally known as the cellular communications industry association) several years ago filed a chart with the U.S. Federal Communications Commission (FCC) presenting a list of target bands for future cellular use (4G/5G). (Figure 1) Several of these bands are currently allocated for telemetry or adjacent to existing global telemetry bands. CTIA members still prefer high-powered exclusive licenses. Clearing a band of incumbents to auction those frequencies becomes difficult due to spectrum congestion, i.e., the lack of a suitable spectrum for existing uses to migrate to.

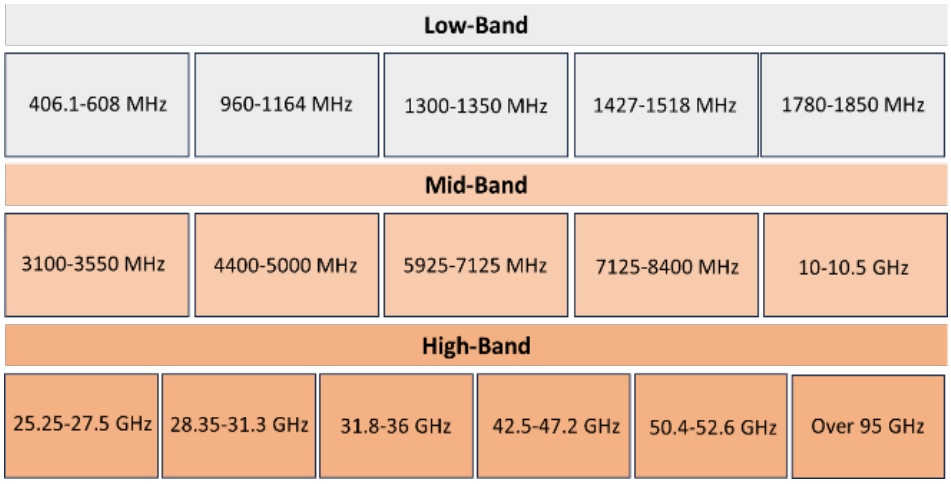

Figure 1. Desired Cellular Bands (CTIA)

Hence, a "battle for the bands" where economic impacts and spectrum utilization becomes a battlefield between several competing services. As telemetry bands become targeted for repurposing, telemetry operations become further cramped and congested, and flight test and other missions are impacted.

Globally, Aeronautical Mobile Telemetry (AMT) capability (real time data, imaging, command and control, time-space-position information) is covered by three bands: L-Band, S-Band, and C-Band (see Fig 3). These bands reside in an RF spectrum "sweet spot" in terms of the physics of these frequencies and the needs of flight test operators. This Region below 7 GHz is ideal for flight test (and other) AMT, where the transmission of data using small low-power transmitters on maneuvering test articles to large, high-gain dish antennas over long distances, up to approximately 320 kilometers, is typical. This Region is also well-suited for a variety of other communications applications, e.g., cellular data services, due to its RF propagation characteristics (penetration of atmospherics, buildings, terrain) [2].

This paper presents a review of international and domestic spectrum issues after WRC-23 with a particular focus on the Agenda for WRC-27. International telemetry vendors, suppliers, and users need to be aware of, and potentially engage with their national administrations on these items.

International Encroachment

The WRC and the ITU

WRCs are held every three to four years. The primary goal of WRCs is to review and maintain the international Radio Regulations in accordance with the United Nation's International Telecommunications Union (ITU) [3] treaty governing the use of the radiofrequency spectrum with the specific objective of protecting against cross-border interference. (Administrations remain free to regulate spectrum as they wish within their own borders consistent with their sovereignty.) The agenda of each WRC is generally established four years in advance, with the final agenda confirmed by the ITU Council about two years before the conference.

A WRC typically will

1) …revise the Radio Regulations (RR), allocations, and requirements
2) …address global radio matters
3) … determine questions for study by the Radio Assembly and Study Groups.

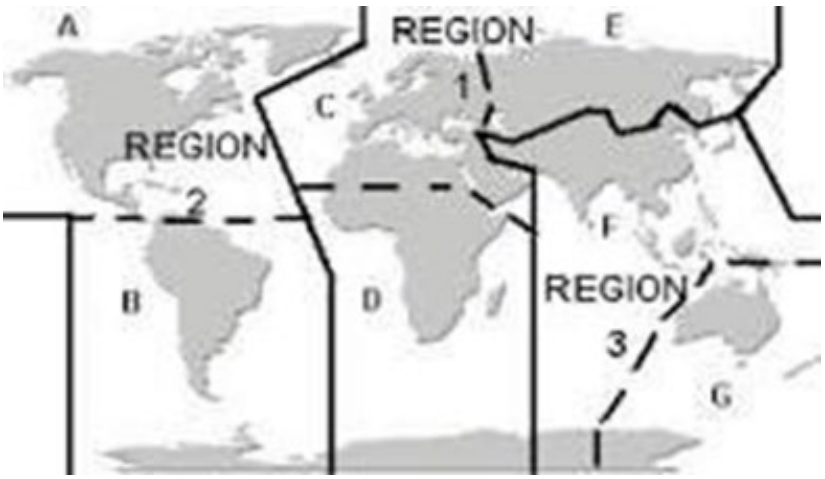

Figure 2. ITU Regions

The ITU's Radiocommunications Sector (ITU-R) manages these Regulations within three geographic Regions (Fig 2). Each Region has its own groups that comprised of the administrations (countries) and commercial interests in that Region which work to develop Regional positions to be pursued at the WRCs.

WRC-23 Results

In December of 2023, the Member States of the ITU closed WRC-23, in Dubai, United Arab Emirates. A record total of 151 Member States signed the WRC-23 Final Acts (twelve participating member States did not sign) which included both new and revised provisions of the Radio Regulations [4]. The main goals of the WRC were to support innovation, deepen global

connectivity, increase access to and equitable use of space-based radio resources, and enhance safety at sea, in the air, and on land.

WRC-23 approved 43 new Resolutions, revised 56 existing Resolutions and suppressed 33 others. Several of the WRC-23 outcomes were of significant interest to AMT users in each Region, affecting a portion or all of several AMT band allocations

Future WRC Agenda Item	WRC-23 Resolution #	Competing Service	Aeronautical Mobile Telemetry Bands (MHz)							
			L-Band		S-Band		C-Band			
			1435	1780	2200	2360	4400	5091	5150	5925
			1525	1850	2290	2395	4940	5150	5250	6700
final	221	IMT/HIBS		X						
final	223	IMT	X	X		X	X			
final	229	WAS							X	
final	744	MSS	X							
27-1.7	256	IMT					X			
27-1.11	249	S-S	X							
27-1.12	252	IoT	X							
27-1.13	253	IMT	X	X	X	X				
31-2.4	683	ISS								X
31-2.9	684	RNSS						X	X	
tbd	225	IMT	X							

Figure 3: WRC Agenda Items with AMT Bands

A review of WRC-27 Agenda Items and Resolutions shows 11 with ties to current AMT bands. Either the band is being considered for a competing non-AMT service or AMT will be adjacent to a new service causing potential adjacent band interference to AMT. There were four Resolutions associated with final decisions, and several Agenda Items set for consideration at WRC-27.

International Mobile Telecommunications (Region 2). IMT allocations already are encroaching on many telemetry bands in several Regions. WRC-23 identified 1300 megahertz of additional radio-frequency spectrum for International Mobile Telecommunications (IMT). The new spectrum identified includes frequency ranges between 3300 MHz and 10.5 GHz on a Regional basis. Fortunately, most of these decisions come with language for the protection of existing services (like AMT).

WRC-23 Resolution 223 was adopted to address terrestrial components of IMT operations in several new bands. This Resolution defines coordination distances for IMT harmonization between administrations with aircraft stations (300 km for land, 450 km for sea) and ground-based stations (70 km) under Article 9.21.

The Resolution includes the upper portion of Region 2's AMT allocation in the lower C-Band (4 800 - 4 990 MHz). Region 2 administrations are encouraged to seek agreement with other Region 2 administrations for any expansion of IMT in this band within their respective borders.

Wireless Access Systems (WAS) (Region 1). WRC-23 also addressed the implementation of WAS in Regions 1's AMT C-Band extension (5 150 – 5 250 MHz). This spectrum was allocated to WAS by WRC-03, and Resolution language includes the need to protect primary services in 5 150 – 5 250 MHz (AMT is a Primary Service in this band). WRC-23 Resolution 229 adopted several criteria for the protection of incumbent services in this band including maximum equivalent isotopically radiated power (e.i.r.p) limits for indoor and outdoor WAS applications.

There is no indication in the Resolution if these limits have been shown to protect AMT operations in the same band. While this Resolution does not specifically address AMT (nor footnote RR 5.446C that allocates this band to AMT) it does state that administrations authorizing WAS stations are invited to take appropriate measures to ensure the protection of incumbent primary services.

This Resolution is not scheduled for future WRC discussions.

Region 1 AMT users need to be aware of and should consider monitoring this possible encroachment as they may need to take measures to monitor and protect AMT transmissions.

HIBS – HAPS as IMT base stations (Region 2). Another hot topic at WRC-23 was HIBS – referring to the use of high-altitude platform stations (HAPS) as base stations for IMT.

HIBS operate in a part of the stratosphere between 18 and 25 kilometers of altitude - much closer to Earth's surface than LEO satellites but high enough to augment terrestrial networks. This makes HIBS ideal to connect communities in rural and remote areas, accelerate 5G deployment at a lower cost, and support disaster recovery communications. But HIBS can also potentially and significantly interfere with adjacent AMT bands. WRC-23 Resolution 221 specified how HIBS should share spectrum safely with other radio services in adjacent bands.

Resolution 221 does protect the mobile services, in the frequency band 1 710-1 885 MHz, specifying limits on specific power flux-density (pfd) (on the order of -111dB(W/(m^2·MHz)) (much less than the ITU-R M.1459 protections (-181 dB(W/(m^2·4 kHz)) used in 1 452 MHz to 1 525 MHz for AMT). The Resolution also requires any administration to protect neighboring aeronautical mobile service systems operating in the frequency band 1 780-1 850 MHz from harmful interference. HIBS administrations must coordinate any planned HIBS operations within 135 km of their neighbor's border.

Of concern, if HIBS are introduced, is the Upper L-Band (1 780 – 1 850 MHz), which is used for AMT in the US. It remains to be seen if AMT will be protected by the agreed pfd limits for HIBS and coordination of neighboring administrations.

" Non-safety" Telemetry (Region 1 and 3). The WRC-23 Final Acts also included allocation of the bands 15.41-15.7 GHz and 22-22.2 GHz (Region 1 and some Region 3 countries) to the aeronautical mobile service for "non-safety" aeronautical applications. This will enable aeronautical platforms (aircraft, helicopters, drones, etc.) conducting surveillance, monitoring, mapping, filming, and other applications to have the capacity to transfer large data sets using wideband radio links.

While not encroachment on any current AMT bands, this spectrum may provide some options for AMT operators.

Radio Quiet Zones (All Regions). Notably the Conference discussions also addressed some concerns on the protection of Radio Quiet Zones. Protecting key zones from radio traffic is vital for scientific research, particularly in astronomy, as it allows for the detection of faint signals from space without interference. The research facilitated by these zones also contributes to local economies and educational opportunities in the remote areas where they are located.

Several of these quiet zones are established in spectrum near AMT bands in various Regions. AMT can interfere with quiet zones stations if not controlled. The criteria adopted by WRC-23 should be applicable to those AMT stations operating in adjacent bands near these zones that might cause cross-border interference, but protecting the other services may put constraints on the use of the AMT bands in certain geographies.

IMT Satellite Expansion (Regions 1 and 2). WRC-23 Resolution 225 designates an additional spectrum which administrations may use for the satellite component of IMT. It resolves that 1 518 – 1 544 MHz (among other bands noted in the Resolution) may be so used. The Resolution does not preclude any existing applications (like AMT) and does not establish a priority for IMT in this band over incumbent uses. It does invite sharing and coordination studies and the reporting of these at a future WRC.

The impact of the Resolution is to be determined, but it could pose an issue for some L-Band AMT users in Regions 1 and 2. Any future sharing and coordination studies need to ensure adequate AMT incumbent protection will be provided as part of studies reported at a future WRC as indicated in the Resolution.

Future WRC Agenda Items (WRC-27 and the 2031 WRC (WRC-31))

Seven adopted Resolutions invited studies or data to support future discussions on spectrum allocation decisions which could impact use of existing AMT allocations. Several are Agenda Items to be resolved at WRC-27. Others are Preliminary Agenda Items that may become part of the Agenda for WRC-31.

The ICTS recommends the global AMT community become aware and track the progress of these future WRC agenda items, especially those pertaining to WRC-27, as they are considered in their relative administrations, ITU-R Working Parties, Regional organizations, and eventually at the WRC.

WRC-23 Agenda Items

WRC-27 Agenda Item 1.7 Terrestrial IMT (Region 2 and Australia) . The appetite for new spectrum designations to support International Mobile Telecommunications (IMT) efforts (like cell phones, wireless, broadband) is insatiable. It is driven by the ITU vision of global mobile access – providing telecommunication services on a worldwide scale regardless of location, network, or terminal used. A primary goal is to facilitate the continued rollout of fifth generation (5G) mobile networks – and support the anticipated future development of sixth generation (6G) services (which are now officially designated "IMT 2030").

Much of the past focus for IMT was on frequency bands previously allocated to the mobile services below 4 GHz. There has been such growth in mobile communications that it is driving an increasing demand for spectrum above 4 GHz.

WRC 23 discussed and adopted an Agenda Item for WRC-27 (1.7) to address sharing and compatibility studies for the potential use of IMT in the frequency bands 4400-4800 MHz

> *…to consider studies on sharing and compatibility and develop technical conditions for the use of International Mobile Telecommunications (IMT) in the frequency bands 4 400-4 800 MHz and 7 125-8 400 MHz (or parts thereof), and 14.8-15.35 GHz taking into account existing primary services operating in these, and adjacent, frequency bands, in accordance with Resolution 256 (WRC-23)*

WRC-23 Resolution 256 seeks to complete studies of issues for sharing and compatibility of these bands with IMT terrestrial operations. It includes much of the 4 400- 4 940 MHz band that was adopted at WRC-07 for AMT in Region 2 and Australia. The current Resolution seeks to use this band for IMT in Regions 1 and 3. The Resolution does not include considering this band for IMT in Region 2 (but this could change in the next two years and WRC-27 will have the final say). The Resolution recognizes the need to protect primary incumbents utilizing this band.

The key word here is "Sharing". It is critical that relevant information to protect AMT operations in the band be presented and referenced, especially information included in previous sharing studies, including ITU-R M.2116, and criteria that are used to provide protection for AMT (like ITU-R M.1459). WRC-23 made no change (i.e., no relaxation) to the power flux density protection criteria for aeronautical mobile systems (which include AMT, as noted above), but critical questions were left unresolved in those discussions that could challenge the relevance of existing protection criteria in the future, even prior to WRC-27.

Adequate criteria to protect incumbent AMT users in 4 400-4 800 MHz must be maintained if the proposed IMT designations in the band move forward. AMT stakeholders in Region 2 should monitor AI 1.17 for any indication that the 4 400-4 800 MHz band will come into play for Region 2 at WRC-27, despite the limitations stated in Resolution 256

WRC-27 Agenda Item 1.11 MSS Space-to-Space Links. WRC-23 also adopted an Agenda Item related to space-to-space links between satellites. This effort seeks to allocate additional spectrum for such links between non-GSO and mobile-satellite satellites (MSS) to relay data to or from the ground in near-real time.

This is planned for part of the L-Band (1 518.0-1 544.0 MHz), at least portions of which are allocated for AMT in several administrations, for example, 1 435-1 535 in Region 2. ITU-R Working Party 4C, which is responsible for this Agenda Item, is studying the technical and operational issues associated with this capability to determine whether these operations are compatible with AMT among other applications. The studies associated with the Resolution will be considered at WRC-27 under agenda item 1.11:

> *… to consider the technical and operational issues, and regulatory provisions, for space-to-space links among non-geostationary and geostationary satellites in the frequency bands 1 518-1 544 MHz, 1 545-1 559 MHz, 1 610-1 645.5 MHz, 1 646.5-1 660 MHz, 1 670-1 675 MHz and 2 483.5-2 500 MHz allocated to the mobile-satellite service, in accordance with Resolution 249 (Rev.WRC-23) . . .*

WRC-23 Resolution 249 invites studies for GSOs in the space-Earth direction in the band 1 525-1 544 MHz adjacent to an AMT band and within the AMT band at 1 518- 1 525 MHz.

The discussions of this Agenda Item will need to be closely monitored by Region 2's AMT users to ensure that appropriate protection criteria remain in effect.

WRC-27 Agenda Item 1.12 MSS Low Data Rate (IoT). WRC-23 also recommends studies be accomplished to increase the MSS spectrum available to implement the "Internet of Things" (IoT). ITU-R members noted that there is a significant need for additional

spectrum for low-data-rate MSS systems to further the developing IoT capabilities globally.

Agenda Item 1.12 and its corresponding WRC-23 Resolution 252 invite studies of possible solutions to implement low-data rate MSS IoT satellites, noting that there is insufficient spectrum for non-voice/low-data-rate non-GSO MSS systems to operate in existing MSS frequency bands below 5 000 MHz. As a result, the ITU-R is conducting studies on sharing and compatibility between the non-GSO low-data-rate MSS systems and the existing primary services operating in the frequency bands 1 427-1 432 MHz for space-to-earth data bursts. WRC-27 Agenda Item 1.12 reads as follows:

…to consider, based on the results of studies, possible new allocations to the mobile-satellite service and possible regulatory actions in the frequency bands 1 427-1 432 MHz (space-to-Earth), 1 645.5-1 646.5 MHz (space-to-Earth) (Earth-to-space), 1 880-1 920 MHz (space-to-Earth) (Earth- to-space) and 2 010-2 025 MHz (space-to-Earth) (Earth-to-space) required for the future development of low-data-rate non-geostationary mobile-satellite systems, in accordance with Resolution 252 (WRC-23) . . .

While the Resolution includes protection of primary incumbents, 1 427-1 432 MHz is near adjacent to a primary AMT Band in Region 2, 1 435-1 535 MHz. This band is being considered for a space-earth MSS link. While space to earth pfd values may be small, so are the strengths of AMT signals. Preliminary analysis indicate there is low risk of harmful adjacent-band interference to airborne AMT radio relays from the proposed systems operating under current ITU OOBE limits. The proposed regulatory framework appears adequate, and all modeled scenarios result in acceptable INR protection margins. This will need to be verified in the WP4C discussions that precede the WRC.

WRC-27 Agenda Item 1.13 MSS-terrestrial IMT. Several ITU-R members reported that the demand for mobile communications in remote and rural areas not covered by terrestrial IMT systems is significant. WRC-23 adopted Agenda Item 1.13 on new spectrum allocations for the Mobile Satellite Service to address this need offering connectivity directly from satellites to unmodified cellular service user equipment through an application now-called Direct-to-Cell MSS IMT (DC MSS IMT). Resolution 253 resolves to study possible allocations to enable DC MSS IMT over the entire range of frequencies between 694 MHz and 2.7 GHz. Agenda Item 1.13 reads (in part) as follows:

> *…to consider studies on possible new allocations to the mobile-satellite service for direct connectivity between space stations and International Mobile Telecommunications (IMT) user equipment to complement terrestrial IMT network coverage…*

Resolution 253 further resolved that administrations should ”conduct studies on sharing and compatibility between incumbent services, including in adjacent frequency bands, ensuring the protection of incumbent services in accordance with the Radio Regulations; [and should] study possible technical and operational measures to ensure that the stations in the MSS do not cause harmful interference to, or claim protection from, stations operating in the mobile service,” which would include AMT stations in the L- and S-Band aeronautical mobile service allocations.

This issue is being studied in ITU-R Working Party 4C. The L- and S- AMT Bands are under consideration. While ITU-R Working Party 5B has now, on at least three occasions since WRC-23 ended, replied to liaison statements issued by ITU-R Working Party 4C to inform the latter that Rec. ITU-R M.1459 may be used to conduct the compatibility studies called for by the Resolution, there are administrations and stakeholders that would be pleased to have Rec. ITU-R M.1459 revisited. The interest in DC MSS IMT seems to be considerable based on ITU-R Working Party 4C meetings thus far. Consequently, this will be a critical watch-item for the global AMT community as sharing and compatibility studies proceed culminating in WRC-27 in two years.

WRC-31 Preliminary Agenda Items

WRC-31 Preliminary Agenda Item 2.4 Inter-Satellite Services (ISS). WRC-23 adopted a Preliminary Agenda Item slated to be taken up in the four-year cycle following WRC-27 which addresses the growing interest in utilizing ISS (inter-satellite service) links between space stations. ISS links are being considered in the frequency band 5 925-6 425 MHz. At WRC-07 this band was allocated for aeronautical mobile telemetry in Region 2.

The band 5 925 – 6425 MHz, the lower portion of the 5 925-6 700 MHz AMT band in Region 2, is being considered for inter-satellite service.

These studies will be discussed at WRC-27 and, if approved, presented as an Agenda Item for consideration at the WRC in 2031. This Agenda Item reads as follows:

> *...to consider, based on the results of ITU Radiocommunication Sector studies, support for inter-satellite service*

allocations in the frequency bands 3 700-4 200 MHz and 5 925-6 425 MHz, and associated regulatory provisions, to enable links between non-geostationary orbit satellites and geostationary orbit satellites, in accordance with Resolution 683 (WRC-23).

This could affect any current or future AMT usage of the 5 925-6 425 MHz band depending on the administration's implementation of the WRC-07 outcome in the band. While WRC-23 Resolution 683 contains language for the protection of other services, any regulatory action taken during Working Party deliberations under WRC-23 Agenda Item 10 (under which agenda items for the following WRC fill be considered and finalized), and discussions leading up to, and at, WRC-31 will need to be monitored by the AMT community to ensure that protection remains intact and adequate if Preliminary Agenda Item 2.4 (WRC-31) is confirmed.

WRC-31 Preliminary Agenda Item 2.9 RNSS (All Regions). WRC-31 Preliminary Agenda Item 2.9, and its accompanying WRC-23 Resolution 684, call for studies on possible new allocations to the radionavigation-satellite service (space-to-Earth). The bands tentatively targeted by the studies (5 030–5 150 MHz and 5 150–5 250 MHz) include spectrum that is key for AMT globally and especially within Region 1. The Preliminary Agenda Item reads as follows:

…to consider possible new allocations to the radionavigation-satellite service (space-to- Earth) in the frequency bands [5 030-5 150 MHz and 5 150-5 250 MHz] or parts thereof, in accordance with Resolution 684 (WRC-23).

5 091 – 5 150 MHz the only globally harmonized AMT Band, i.e., it is allocated for AMT in all Regions. RR Footnote 5.444B limits this band to aeronautical mobile (R) service, and AMT in all three Regions. Resolution 684 notes the presence of this allocation, and any subsequent Working Party studies on sharing and compatibility with incumbent services should be monitored to ensure adequate protection from RNSS encroachment is provided in the event this Preliminary Agenda Item is confirmed at WRC-27 (through Agenda Item 10) for WRC-31.

Another AMT band potentially affected by this Preliminary Agenda Item in Region 1 and in Brazil is 5 150- 5 250 MHz. This allocation is not mentioned in Resolution 684.

It should also be noted that the regulatory status of the 5 150-5 250 MHz band for AMT in Region 1 is unclear. According to the Radio Regulations, AMT is "primary" in this band in Region 1 (see RR 5.444C) and in Brazil (RR 5.444D). However, RR 5.444C (for Region 1) also states that "[t]hese [AMT] stations shall not claim protection from other stations operating in accordance with Article 5"– a qualification which is absent from the footnote for Brazil.

While neither of the footnotes is referenced in the Agenda Item's Resolution 684, the AMT community can take some comfort from the fact that *recognizing a)* in Resolution 684 prescribes:

…that the possible addition of the RNSS (space-to-Earth) in the frequency bands [5 030 5 150 MHz and 5 150-5 250 MHz], or parts thereof, shall ensure protection of, and not impose constraints on, the development of incumbent services in the same and adjacent bands…

Nevertheless, as noted above, a question is presented with regards to the primary allocation status for AMT in this band in Region 1. Simply, if the status of the allocation is revisited, this could pose an issue for Region 1 AMT users and is a matter which should be clarified in the event this Preliminary Agenda Item 2.9 is ultimately approved at WRC-27 (under Agenda Item 10) for WRC-31.

Domestic Encroachment

While ITU Radio Regulations are determined at the WRC governing the regulation of cross-border interference, each administration (country) maintains sovereignty over the use of the electromagnetic spectrum within its border and adopts national regulations for domestic use apart from, and which may differ from, ITU Regulations. This section addresses a few regulatory issues related to AMT in specific administration as reported to ICTS members.

All Administrations

Middle C-Band The band 5 091-5 150 MHz was allocated to AMT at WRC-07. This is the globally harmonized AMT band across all three Regions and is available to all administrations.

AMT is co-primary in this band with aeronautical mobile route service (AM(R)S) and the aeronautical radionavigation service (ARNS) which use this band for ground and traffic control at some major airports (see ITU-R RR 5.444B).

These services (AMT, AM(R)S, ARNS) are typically geographically separated for mutual protection. Currently 5 030 – 5 250

MHz has been defined by the Radio Regulations for ARNS. 5 030- 5 091 MHz has a defined ARNS function- namely for the microwave landing system (MLS) and the Airport Location and Network Equipment (ANLE). In the US, the Federal Aviation Administration (FAA) uses 5 091-5 150 MHz band for the Aeronautical Mobile Airport Communications System (AeroMACS) to support air traffic on the surface of airports. Few airports, at least in the U.S., have implemented MLS or ANLE/AeroMACS. AMT users seeking to use 5 091-5 150 MHz near major airports should monitor the ARNS and ANLE usage and ensure geographical separation.

While utilization of the 5 GHz band for AMT is slowly growing, its full potential has not been realized in several administrations, and this band could face encroachment from other commercial services if it appears underutilized.

United States

Lower L-Band --Cellular Interference (U.S.). While 1 350- 1 390 MHz is currently not on any reallocation proposal, it is perceived as threatened as it is on several commercial desired spectrum lists due to its proximity to other low-band cellular spectrum. Present in this band are critical time-space positioning information data links (Advanced Range Data System (ARDS), Common Range Integrated Instrumentation System (CRIIS), which may be affected by adjacent channel interference from future commercial devices. This much-sought-after band should be a watch item for test and training ranges that rely on GPS-based TSPI instrumentation.

S-Band. The U.S. Congress required the Federal Communications Commission (FCC) three bands between 2 025 and 2 395 MHz for commercial space launch on a secondary basis – including 2 360- 2 395 MHz. These is a critical AMT band for flight testing in the US and protection issues are currently being considered as the FCC implements per-launch coordination procedures and selects a third-party coordinator who will be the facilitator of coordination requests and function as an intermediary between space launch operators and incumbent users and incumbent coordinators.

AMT's primary status in this band may face some challenges. Secondary status may not be satisfactory for commercial space launch when a launch countdown is underway, or a launch has commenced. It is unclear what would happen if an AMT user requested that a coordinated launch be scrubbed for a subsequently scheduled AMT flight test. The politics of such a prioritization decision may require a different approach to managing prioritization.

In addition, there is reported interest by AT&T, the nationwide licensee in the 2 345-2 360 MHz band for Wireless Communications Service (WCS), and its satellite partner, AST SpaceMobile, to implement a direct-to-cell type service in AT&T's spectrum, referred to in the U.S. as Supplemental Coverage from Space (SCS). While AT&T's use of this band for base stations as part of its terrestrial WCS deployment is coordinated with Federal and non-Federal coordinators, a deployment of SCS in this band would present novel coordination challenges different in nature than international DC MSS IMT under AI 1.13, which is limited to cross-border interference concerns.

Lower C-Band The recently signed Budget Reconciliation Bill (H.R. 1) mandates that at least 800 megahertz of spectrum be auctioned to support US Domestic commercial high powered wireless operations before September 30, 2034, with the first tranche auctioned rom the non-government 3 980 – 4 200 MHz band (at least 100 MHz) by no later than July 4, 2027. The bands under consideration for this requirement include the so-called" covered band," namely, spectrum between 1.3 and 10.5 GHz (excluding 3.1-3.45 GHz and 7.4-8.4 GHz and, presumably, other bands already auctioned for commercial uses). NTIA was provided $50M to conduct a "timely spectrum analysis" of 2 700 – 2 900 MHz, 4 400 – 4 900 MHz, and 7 250 – 7 400 MHz to "support" the NTIA Administrator with no specified deadline other than September 30, 2034, at the outside. AMT is a current user of the 4 400 – 4 940 MHz band in the US, and multiple developmental efforts are currently funded related to future AMT technologies and capabilities in this band. US users will need to monitor the forthcoming NTIA analyses and recommendations of spectrum bands for auction to satisfy the 800-megahertz target to ensure there are no impacts to telemetry operations from this recently signed Bill.

Upper C-Band The band 5 925-6 425 MHz was allocated for aeronautical mobile telemetry during WRC-07 in Region 2. While research has been accomplished showing a potential solution to aggregate the fragmented spectrum into AMT channels, in the U.S. 6 GHz spectrum in just the past five years has been made available for unlicensed Wi-Fi use in addition to pre-existing licensed use by several radio services, greatly diminishing the chances for an AMT allocation in this region of the spectrum.

Germany

C-Band. The German administration has granted AMT allocations only in the C- Band range (typically) 5 091-5 150 MHz. Currently not in the range 5 150-5 250 MHz (as allocated by the ITU-R).

While the C-band allocation is available for Germany, it may not be allocated in adjacent countries. Due to the typical flight range and altitude of flight test missions, many test organizations may need to request C-Band allocation for the countries on their borders. Regional coordination can be bureaucratic and complex and needs to be completed well before the test can be scheduled.

S-Band. A major user used to have frequency assignments in the S-Band (2 300 – 2 360 MHz) for AMT within Germany. In 2024, the German administration refused to extend these assignments, despite many negotiations.

Conclusions

Challenges Ahead
Significant encroachment challenges to telemetry spectrum exist both domestically (within individual administrations or Regions) and internationally (ITU/WRC). The encroachment of incompatible services in-band and adjacent to bands used for AMT can degrade telemetry data and result in test failure, loss of test articles, and risks to pilots', crews', and other persons' safety. Adequate RF spectrum for telemetry operations is critical for flight test and other scientific applications.

Data for Decision Makers
Defending telemetry spectrum is critical to preserving test capabilities. The cost and benefits of telemetry spectrum is difficult to articulate when compared to other commercial uses. Telemetry users must be prepared to provide convincing data on the need for real-time and error-free receipt of telemetry streams to support flight testing to effectively defend the spectrum used for flight test (and other) telemetry services. Data on spectrum utilization by telemetry and impacts to flight test must be understandable and available for response to domestic and ITU data calls.

Flight test telemetry is a critical link in the test and evaluation chain of events that is required to safely complete a test program in a timely fashion and within budget. Telemetry, as a "late-in-the-cost-chain" asset, can be a significant cost driver where a failure (mission cancellation) could cause expensive down-chain impact (cost/schedule) in a test program (targets, test environments, test assets, ranges).

To adequately defend telemetry spectrum, capturing and articulating these costs must be accomplished, and telemetry operators must be prepared to act on guidance on how to provide data on cost impacts to domestic and ITU decision makers.

A Global AMT Band
AMT users also must take better advantage of the spectrum to which we have access. The ITU has recognized the critical international character of AMT and at WRC-07 provided us a Global AMT Band (Fig 4). This band (5 091- 5 150 MHz) is globally harmonized and ready to be allocated for aeronautical telemetry world-wide, All telemetry users are encouraged to

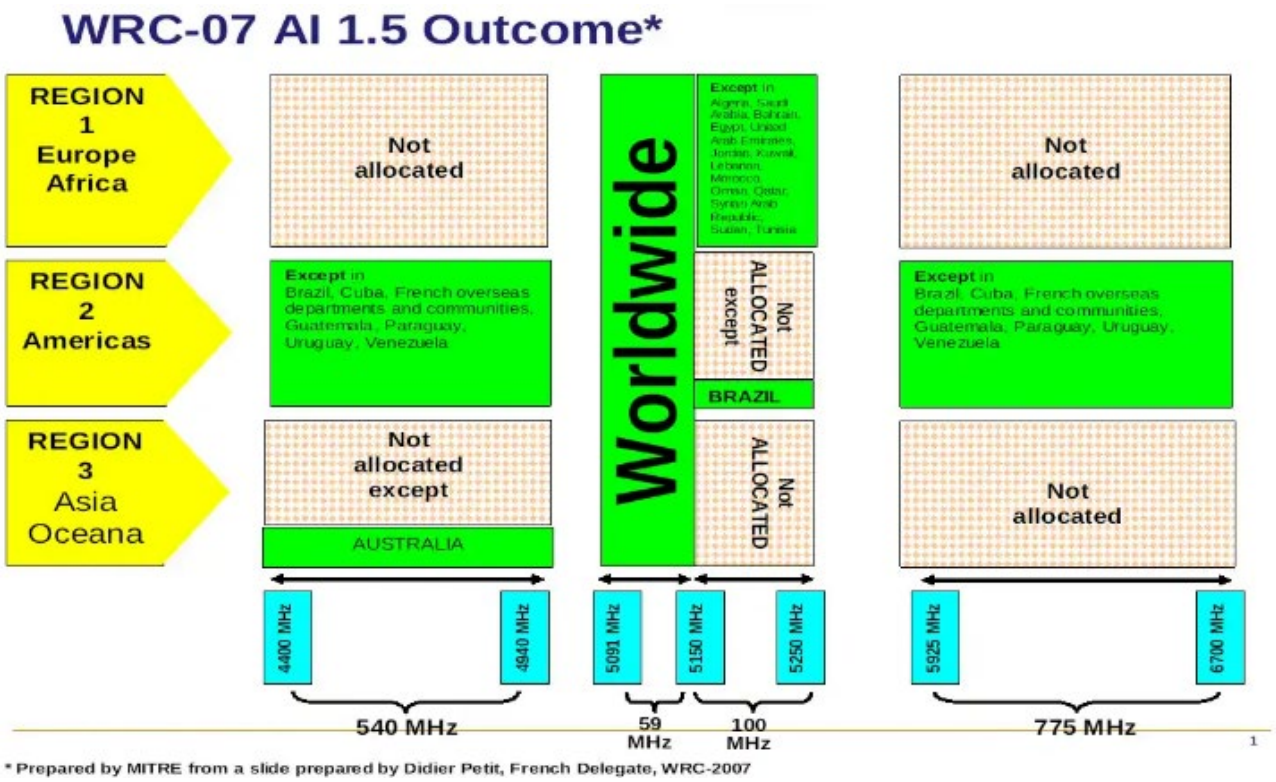

Figure 4. WRC-07 AMT Results

make use of this dedicated AMT band.

Taking Action

The information in this paper is presented so that telemetry practitioners are aware of many of the primary developments that could affect the business of telemetry and can take the necessary action to preserve and protect this vital capability for safe and timely aeronautical flight tests.

Acknowledgment

The authors represent the International Consortium for Telemetry Spectrum (ICTS, which was formed in 1999 and is chartered under the sponsorship of the International Foundation for Telemetering (IFT) [5]. The IFT is a non-profit organization dedicated to serving the professional and technical interests of the telemetering community. The ICTS is comprised of international telemetry providers, users, and customers [6]. The information provided here is collected by ICTS members, their companies, and telemetry providers, We'd like to thank them all for providing this information, especially

Ray Faulstich	Luc Falga	Gilles Freau	Scott Hoschar
Ken Keane	Heiko Koertzel	Murdo MacKinnion	Gerhard Mayer
Sergio Penna	Eric Prescott	Jamie Presser	Luiz de Souza
Renaud Urli	Guy Williams	Chip Yorkgitis	

The ICTS is dedicated to serving the professional and technical interests of those in the telemetering community and welcomes your involvement.

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Glossary

AM(R)S:	Aeronautical Mobile Route Service
AMT:	Aeronautical Mobile Telemetry
ARNS:	Aeronautical Radio Navigation Service
ANLE:	Airport Location and Network Equipment
CTIA:	Cellular Trade Industry Association
e.i.r.p.:	equivalent isotopically radiated power
FAA:	Federal Aviation Administration
FCC:	Federal Communications Commission (USA)
ICTS:	Int'l Consortium for Telemetry Spectrum
IFT:	Int'l Foundation for Telemetering
IMT:	International Mobile Telecommunications
IoT:	Internet of Things
ISS:	Inter-Satellite Service
ITU:	International Telecommunications Union (UN)
ITU-R:	ITU's Radiocommunications Sector
GHz:	Gigahertz (10^9 hertz)
GPS:	Global Positioning System
GSO:	Geostationary Satellites
HAPS:	High-altitude platform station
HIBS:	HAPS as base stations for IMT
kHz:	Kilohertz (10^3 hertz)
MHz:	Megahertz (10^6 hertz)
MLS:	Microwave Landig System
MSS:	Mobile Satellite Services
OOBE:	Out Of Band Enge
pfd:	power flux-density
RF:	Radio Frequency
RNSS:	Radionavigation-Satellite Service
RR:	Radio Regulations (ITU-R)
SCS:	Supplemental Coverage from Space
S-S;	satellite to satellite
TSPI:	time-space positioning information
WAS:	Wireless Access Systems
WCS:	Wireless Communications Service
WiFi:	Wireless Fidelity (IEEE 802.11)
WPxx:	ITU Working Party
WRC:	World Radiocommunications Conference
5G	fifth generation mobile networks