Telemetry Spectrum Encroachment Post-WRC-23

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Abstract: A review of international and domestic spectrum issues that can challenge the future use of radio frequency telemetry after the 2023 World Radiocommunications Conference. 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 are also presented. 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 for usable telemetry spectrum. Several factors have revolutionized demand for electromagnetic spectrum. These factors include:

- Very congested RF spectrum, especially in the communications bands below 7 GHz.
- Increasing need for 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 (less spectrum is available).

As an example, CTIA [1] (originally known as the Cellular Telecommunications 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 or adjacent to existing global telemetry bands. CTIA members still prefer exclusive licenses. Clearing a band of incumbents to auction those frequencies becomes difficult due to spectrum congestion.

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.

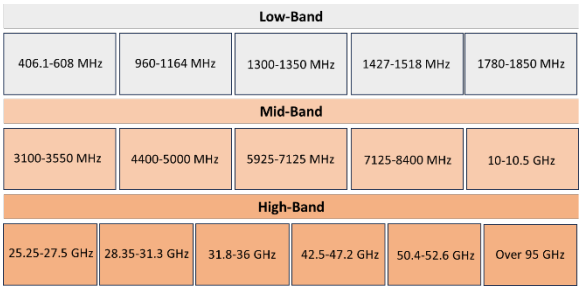

Figure 1. Desired Cellular Bands (CTIA)

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." This Region below 7 GHz is well-suited for communications due to its RF propagation characteristics (penetration of atmospherics, buildings, terrain) [2].

This Region is also 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, is typical. It is also attractive for cellular operators for many of the same reasons.

This paper presents a review of international and domestic spectrum issues after the 2023 World Radiocommunications Conference (WRC) with a particular focus on the Agenda for the next WRC in 2027. 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

World Radiocommunication Conferences (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. The agenda of World Radiocommunication Conferences is generally established four years in advance, with the final agenda set 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.

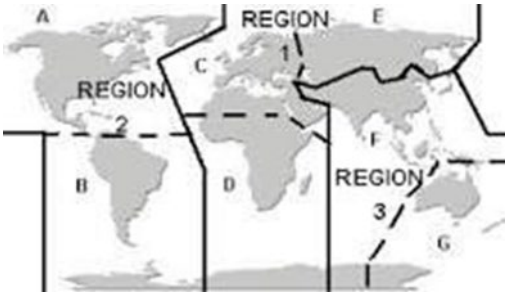

Figure 2. ITU Regions

The ITU's Radiocommunications Sector (ITU-R) manages these Regulations within three Regions (Fig 2). Each Region has its own groups that represent the administrations (countries or commercial interests) in that Region.

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 which included both new and revised provisions of the Radio Regulations [4]. The main goals of the WRCs 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 and suppressed 33. These and other agreements provided updates to the Radio Regulations identifying several potential new spectrum allocations of significant interest to AMT users in each Region.

Future WRC Agenda Item	WRC-23 Resolution #	Competing Service	Aeronautical Mobile TelemetryBands (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/HBIS		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 a new service with potential adjacent band interference. There were four Resolutions associated with final decisions, and several Agenda Items tentatively set for WRC-27.

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

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 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.

Wireless Access Systems (WAS) (Region 1) WRC-23 also addressed the implementation of wireless access systems (WAS) in Regions 1's AMT C-Band extension (5 150 – 5 250MHz). This 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). Resolution 229 adopted several criteria for the protection of incumbent services in this band including maximum effective isotropic radiated power (EIRP) 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 are requested to maintain protection to the other primary services.

This Resolution is not scheduled for future WRC discussions. The Resolution invites Region 1 administrations to allow these stations to operate in this band. It also requires they take appropriate measures to protect primary incumbents.

Region 1 AMT users need to be aware of this possible encroachment and 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).

HIBS operate in a part of the stratosphere between 18 and 25 kilometers of altitude - much closer to Earth's surface than low earth orbit (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, support disaster recovery communications, but also potentially interfere with adjacent AMT bands. WRC-23 Resolution 221 specified how HIBS should share spectrum safely with other radio services in adjacent bands. HIBS – due to their low altitude – could cause significant interference for AMT in adjacent countries/adjacent bands.

The Resolution does protect mobile service, in the frequency band 1 710-1 885 MHz, specifying limits on specific power flux-density (pfd) (on the order of -111dB (W/(m2 · MHz))(much less than the ITU-R M.1459 protections (-187 dB(W/(m2 · 4 KHz used elsewhere 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 neighbors' borders.

Of concern is the Upper L-Band (1 780 – 1850 MHz), used for AMT in the US. It is hoped that AMT will be protected by the agreed pfd limits for HIBS and coordination of neighboring administrations.

"Non-safety" Telemetry (Region 1, 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, …) conducting surveillance, monitoring, mapping, filming, and other application to have the capacity to transfer large data sets from these using wideband radio links.

While not an encroachment on any current AMT bands, it 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. These zones also contribute to local economies and educational opportunities in the remote areas where they are located.

Several of these quiet zones are near AMT bands in various Regions. AMT can interfere with these stations if not controlled. The criteria adopted by WRC-23 should be applicable to those AMT stations operating in adjacent bands near these zones.

IMT Satellite Expansion (Region 1, 2) WRC-23 Resolution 225 designates 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. 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 is provided as part of studies reported at a future WRC as indicated in the Resolution.

Future WRC Agenda Items

Seven adopted Resolutions either sought studies or data to support future discussions on spectrum allocation decisions. These became WRC Agenda Items to be resolved at a future WRC.

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

WRC-27 Agenda Item 1.7 Terrestrial IMT (Region 2 and Australia) The appetite for spectrum 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 possibly support the future development of 6G services (which are now officially designated "IMT 2030").

Much of the past focus for IMT was on previously allocated frequency bands below 3 GHz. There has been such growth in mobile communications that it is driving an increasing demand for spectrum above 3 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)

Resolution 256 seeks to complete studies of issues for sharing and compatibility of these bands with IMT terrestrial operations. It affects 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 the Conference has 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 protective information be presented and referenced. Especially relating to 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 proposed power flux density protection level for aeronautical mobile systems (which includes AMT as noted above), but critical questions were left unresolved in those discussions that could change that status in the future.

Adequate protection criteria must be provided for incumbent AMT users in 4 400-4 800 MHz.

WRC-27 Agenda Item 1.11 MSS Space to Space Links (Region 2) 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-geostationary orbit (non-GSO) and mobile-satellite service (MSS) satellites 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 Region administrations. 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);

Resolution 249) invites studies for the GSO 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) (Region 2) 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 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 Resolution were adopted to study possible solutions 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. This band is being considered for a space-earth MSS link. While space to earth pfd values may be small, so are AMT signals. Appropriate AMT adjacent band interference protection should be included in these incumbent protection studies.

WRC-27 Agenda Item 1.13 MSS-terrestrial IMT (All Regions) 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. Resolution 253 resolves to study possible allocations to enable direct connectivity between satellites and IMT user equipment. This Resolution will look for additional spectrum in a wide swath of spectrum between 694 MHz and 2.7 GHz. Agenda Item 1.13 reads 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…

This issue is being studied in ITU-R Working Party 4C. The L- and S- AMT Bands are under consideration. This will be a critical watch-item for the global AMT community as sharing

and compatibility studies proceed.

WRC-31 Agenda Item 2.4 Inter-Satellite Services (ISS) (Region 2) Another WRC-23 Agenda Item addresses the growing interest in utilizing ISS links between space stations. This is 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 – 6 425 MHz, the lower chunk of the 5 925-6 700 MHz AMT band in Region 2, is being considered for Earth-to-space inter-satellite service.

These studies will be discussed at WRC-27 and, if approved, presented as an Agenda Item for the Conference in the year 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. While the Resolution contains language for the protection of other services, any regulatory action taken during Working Party deliberations and at WRC-31 will need to be monitored by the AMT community to ensure that protection remains intact.

WRC-31 Agenda Item 2.9 RNSS (All Regions) WRC-31 provisional Agenda Item 2.9, and its accompanying Resolution 684, seek 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 within Region 1. The 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 Agenda Item is approved for WRC-31.

Another AMT band potentially affected by this 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 "These [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 could pose an issue for Region 1 AMT users and is a matter which should be clarified in the event this Agenda Item is ultimately approved.

Domestic Encroachment

While ITU Radio Regulations are determined at the WRC, each administration (country) has national regulations in place apart from ITU Regulations. This section addresses a few regulatory issues related to AMT in specific administrations 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 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 5091-5150 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 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 this band (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.

Lower S-Band. The United States Federal Communications Commission has determined that additional bands should be allocated for commercial space launch on a secondary basis – including 2 360- 2 395 MHz. These are critical AMT bands for flight testing in the US and scheduling/protection issues are currently being considered.

AMT's primary status in this band may face some challenges. Secondary status may not be satisfactory for commercial space launch when you've got a launch countdown underway, and the launch needs to be scrubbed for a scheduled AMT flight test. The politics of such a prioritization decision may require a different approach to scheduling and allocation prioritization.

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 has been allocated for unlicensed Wi-Fi use, greatly diminishing the chances for an AMT allocation.

Germany

C-Band. The German administration granted 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.

Australia

L-Band. The Australian national regulators have initiated a public process towards determining future use of the 1427-1535 MHz band. The Australian Communications and Media Authority (ACMA) is in the preliminary stages to identify detailed replanning options including options for IMT use of the broader 1427–1535 MHz frequency range within Australia. There is interest in using the band for wireless broadband from both mobile network operators and private operators. ACMA plans for a thorough consideration of the spectrum uses and utility in the public interest. Their efforts will include detailed technical co-existence studies, high-level technical planning frameworks, and incumbent spectrum needs to identify available mitigations that address any adverse impacts.

Australian telemetry users will be under pressure to retain spectrum access to this critical band. This could have significant impact on Australian domestic aeronautical telemetry services and will need to be considered as part of any replanning process.

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 impairments to test 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 to 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. 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 provide cost impacts to domestic and ITU decision makers.

A Global AMT Band

We 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 make use of this dedicated AMT band.

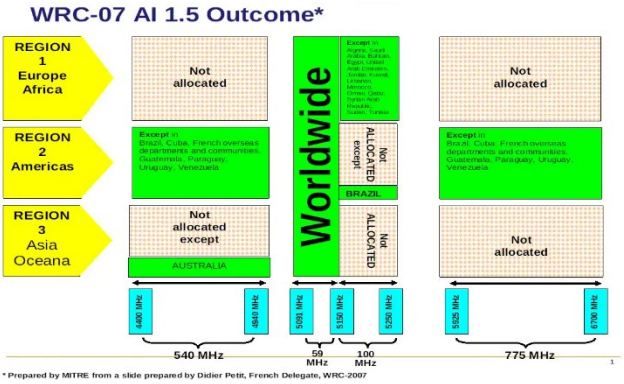

Figure 4. WRC-07 AMT Results

Taking Action

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

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

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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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[5] *International Foundation for Telemetering* (IFT), www.telemetry.org/who-we-are/

[6] *International Consortium for Telemetry Spectrum* (ICTS), www.telemetryspectrum.org

Glossary

ACMA	Australian Communications and Media Authority
AM(R)S:	Aeronautical Mobile Route Service
AMT:	Aeronautical Mobile Telemetry
ARNS:	Aeronautical Radio Navigation Service
ANLE:	Airport Location and Network Equipment
EIRP:	effective isotropic radiated power
FAA:	Federal Aviation Administration (USA)
FCC:	Federal Communications Commission (USA)
ICTS:	International Consortium for Telemetry Spectrum
IFT:	International Foundation for Telemetering
IMT:	International Mobile Telecommunications
IoT:	Internet of Things
ITU:	International Telecommunications Union (UN)
ITU-R:	ITU's Radiocommunications Sector
GHz:	Gigahertz (10^9 hertz)
GPS:	Global Positioning System
GSO:	geostationary orbit
HAPS:	High-altitude platform station
HIBS:	HAPS as base stations for IMT
KHz:	Kilohertz (10^3 hertz)
MHz:	Megahertz (10^6 hertz)
MLS:	Microwave Landing System
MSS:	Mobile Satellite Services
pfd:	power flux-density
RF:	Radio Frequency
RNSS:	radionavigation-satellite service
RR:	Radio Regulations (ITU-R)
TSPI:	time-space positioning information

WAS: Wireless Access Systems
WiFi: Wireless Fidelity (IEEE 802.11)
WRC: World Radiocommunications Conference
5G fifth generation mobile networks