

TELEMETRY SPECTRUM ENCROACHMENT UPDATE

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ABSTRACT

A review of spectrum issues that can encroach on the future use of RF telemetry. The International Consortium for Telemetry Spectrum will review current status of agenda items that address telemetry to be presented at the 2023 World Radiocommunication Conference that telemetry vendors and users need to be aware of and potentially engage with their national administrations.

The International Consortium for Telemetry Spectrum (ICTS, www.telemetryspectrum.org) was formed in 1999 and is chartered under the sponsorship of the International Foundation for Telemetry (IFT). The IFT (www.telemetry.org) is a non-profit organization dedicated to serving the professional and technical interests of the telemetry community.

This paper provides an update to spectrum encroachment threats per each telemetry band perceived by the ICTS as of interest to the US domestic and greater international telemetry community.

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INTRODUCTION

Several factors within and external to the telemetering community have revolutionized demand for electromagnetic spectrum, including spectrum allocated for flight test telemetry. These factors include:

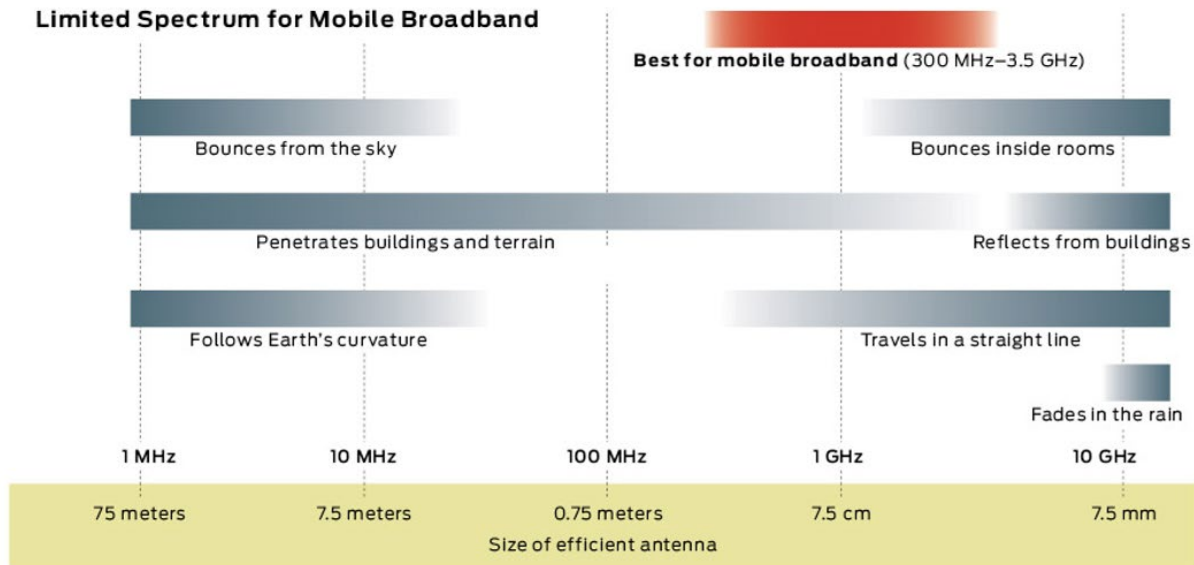
- Commercial Radio Frequency (RF) spectrum utilization is increasing rapidly and this trend is expected to continue
- Real-time data and video telemetry is critical to the economic viability of the commercial aeronautical industry
- Frequency bands used for telemetry have been reallocated for other use and continue to be at risk of reallocation
- Telemetry data rates are increasing, thereby increasing the RF bandwidth needed for each mission

Telemetry users are caught between a rock (telemetry demand is increasing) and a hard spot (less spectrum is available for telemetry).

LOW-BAND					
406.1-608 MHz	960-1164 MHz	1300-1350 MHz	1427-1518 MHz	1780-1850 MHz	
MID-BAND					
3100-3550 GHz	4400-5000 GHz	5925-7125 GHz	7125-8400 GHz	10-10.5 GHz	
HIGH-BAND					
25.25-27.5 GHz	28.35-31.3 GHz	31.8-36 GHz	42.5-47.2 GHz	50.4-52.6 GHz	Over 95 GHz

Fig 1; Desired 4G/5G Bands (CTIA)

As an example, in the US CTIA (the cellular industry trade association) has filed the above chart with the FCC presenting a list of target bands for future cellular use (4G/5G) (fig 1). While many carriers still prefer exclusive licenses, the spectrum is congested. Clearing a band of incumbents so as to auction those frequencies maybe no longer be effective. Spectrum sharing must be our watchword going forward.



OPPORTUNITY WINDOW: The best frequencies for mobile broadband are high enough that the antenna can be made conveniently compact, yet not so high that signals will fail to penetrate buildings. This leaves a relatively narrow range of frequencies available for use [red band].

Fig 2; RF Spectrum “Sweet” Spot

Several of the bands indicated above are critical to both domestic (US) and international operations for Aeronautical Mobile Telemetry (AMT) and associated operations (telemetry command and control, time space positioning information, ...). In the US these bands include 1427-1518, 1780-1850, 4400-5000 MHz and, for TSPI, 1300-1350 and 1427-1518 MHz

These bands reside in an RF spectrum “Sweet Spot” (See Fig 2). This spot, between 300 MHz and 3500 MHz, is well suited for mobile communications due to its RF propagation characteristics. For example, this spot is ideal for AMT, where we seek to transmit data over long distances using low power transmitters on maneuvering test articles. It is also ideal for cellular operations, such as voice and broadband, for many of the same reasons.

Regardless of whether spectrum is sought for exclusive use or sharing, the spectrum encroachment threat level for spectrum-dependent systems (especially AMT and TSPI) remains “High”.

CURRENT THREAT SUMMERIES

Lower L-Band (1350-1390)

Current Use: In the U.S. this band is critical for time space positioning information data transmission/data linkage.

Spectrum Threat(s):

Cellular Interference. While the band is currently not perceived as threatened, it is on several target lists due to its proximity to other “low band” spectrum. There is a concern that that TSPI data links (ARDS, CRIIS, 1350-1390 MHz)) may be affected by adjacent channel interference from cellular operation below 1350 Mhz. This is a watch item for test and training ranges that rely on GPS-based TSPI I instrumentation as the susceptibility of the TSPI data link operations to LTE interference is unknown as this time. Efforts to access this susceptibility, and necessary protection criteria, are needed to analyze this threat.

L-Band (1435-1525 MHz)

Current Use: Allocated for manned AMT in the U.S. This is the primary mother-AMT band in the U.S. and is used for AMT by a number of other administrations as well.

Spectrum Threat(s):

Int’l Mobile Telecommunications. The ITU Radio Regulations give AMT priority over IMT in 1435-1535 MHz in Region 2 (North and South America). It remains high on the list of encroachment concerns for ICTS as it resides in the low band “sweet spot” for RF propagation characteristics for international mobile communications. While the ITU regulations are clear, the threat to AMT protection criteria and assignments is real and constant in the World Radiocommunication Conference discussions. ITU Recommendations M. 1459 and 2116 are relevant for AMT protection criteria.

Ligado. The upper part of the L-band is also home to several global positioning systems (GPS). Along with AMT operations below 1525 MHz, one of these signals is potentially threatened. L1 (encrypted precision code, coarse acquisition code), at 1575.42 MHz, could receive interference from a terrestrial data link proposed by Ligado Networks (Reston, VA) in the U.S. The Federal Communication Commission (FCC) issued an Order in April 2022 granting the Ligado application for 1526-1536 MHz, 1627.5-1637.5 MHz, and 1646.5-1656.5 MHz operations for a terrestrial Internet of Things (IoT) network. A number of agencies and commercial interests filed Petitions for Reconsideration due to concerns about interference to GPS. If this IoT network is implemented, it could have significant impact on GPS dependent systems (like TSPI). In the National Defense Authorization Act (NDAA-21), Congress added language that bars use of funds by DOD to retrofit any GPS device or system in order to mitigate interference from Ligado or to contract with Ligado until such operations are shown not to cause harmful interference to DOD GPS devices. NDAA-21 also calls for an independent technical review of the FCC’s Order

by National Academies of Sciences, Engineering and Medicine. This is still a very lively debate inside the U.S.

Commercial Space Launch: Again, in the U.S. the FCC is considering potential allocation of other bands for commercial space launch. One commenter (Virgin Galactic) has asked for space launch allocation in 1435-1525 MHz The ICTS is monitoring this request.

Upper L-Band (1780-1850 MHz)

Current User: Allocated for manned AMT in the US.

Spectrum Threat(s):

AWS-3 Auction. In 2014 the Federal Communications Commission started the process of auctioning 65 MHz of spectrum to meet the goals of the National Broadband Plan. This was the third of three auctions required for funding the FirstNet, public safety broadband network and other services. Previous auction results had raised nearly \$1.6 billion of the \$7 billion needed. The AWS-3 auction generated \$44.9 billion. As a result, several government users were compensated to vacate the band. AMT operations, previously in the band 1755-1780 MHz, were compressed into the remaining spectrum between 1780 and 1850 MHz. The ICTS is concerned that the commercial interests are not satisfied and will return for the remainder of the band.

HIBS: This band is also in discussion for ITU consideration at the next World Radio-communications Conference (WRC). WRC-23 Agenda Item 1.4: “to consider . . . the use of high-altitude platform stations as IMT base stations (HIBS) in the mobile service in certain frequency bands below 2.7 GHz already identified for IMT, on a global or regional level [such as 1780-1850 MHz];”. Discussions on this are ongoing in several ITU-R working parties.

Lower S-Band (2200-2290 MHz)

Current Use: Allocated for unmanned AMT in the US.

Spectrum Threats(s):

Commercial Space Launch: In the U.S. the FCC has allocated four five-megahertz segments in 2200-2290 MHz for non-federal space launch operations on a secondary basis. This is a non-Federal allocation limited to telemetry/tracking during pre-launch testing and space launch operations. It will require coordination with the NTIA for each launch pending adoption of service rules. NTIA recommends that DoD Area Frequency Coordinators (AFCs) deconflict and approve use of the allocations. While the FCC is considering potential allocation of other bands for commercial space launch including 2025-2110 MHz and 2360-2390 MHz -- about which more below -- it also is considering upgrading this secondary 2200-2290 MHz non-Federal allocation to primary status; potentially a major impact to AMT operators in the U.S.

The Aeronautical and Flight Test Radio Coordinating Council (AFTRCC) has been proposed to coordinate non-Federal space launch requests with the DOD AFCs.

Upper S Band (2360-2390 MHz)

Current Use: Allocated for manned AMT in the US.

Spectrum Threat(s):

Commercial Space Launch: In the US, the FCC is considering potential allocation of several additional bands for commercial space launch -- including 2360-2390 MHz .

Lower C-Band (4400-4940 MHz)

Current Use: ITU Region 2 (North/South America) allocations for AMT. U.S. Major Range and Test Facility Base (MRTFB) installations have several AMT allocations in this band.

Spectrum Threat(s):

Non-Federal Use: In the U.S., AFTRCC has submitted a proposal to the FCC for a non-federal AMT allocation in this band with DoD support. AFTRCC would coordinate use of any such allocation, if approved, with DoD AFCs.

R-ALT Interference: In the band below 4400-4940 MHz, there has been major controversy regarding 5G compatibility in the band 3700-3980 MHz with radar altimeters (R-Alt) operating in the band 4200-4400 MHz. An FAA Special Airworthiness Information Bulletin calls on R-Alt vendors and others to provide data on specific R-Alts; to assess the need for mitigation beyond the recommended action. Meanwhile, AT&T and Verizon have agreed to delay deployment of 5G operations in 3700-3980 MHz.

WRC Threat: The upper portion of the 4 GHz band, namely 4800-4990 MHz, is identified for IMT in numerous countries (including China, South Africa, Russia, Nigeria, Gambia, Uruguay, and Iran). WRC-23 agenda item 1.1 calls for studies to consider measures to protect stations of the aeronautical and maritime mobile services located in international airspace and waters from IMT operations in the 4800-4940 MHz band. France, the U.S., Canada and other administrations have sought to protect Aeronautical Mobile Service systems (AMS, AMT is included in AMS) and Maritime Mobile Service systems. Russia, supported by China, Iran, and others have sought changes that would weaken existing protection for AMS/MMS in international airspace and waters. This is currently a hotly debated issue that will probably not be resolved until the WRC. This is being worked in ITU-R Working Parties 5D and 5B. Work done in the U.S. (by, for example, John Hopkins University's Applied Physics Lab personnel) has determined that criteria specified in ITU-R M.2116 can protect AMT signals, and the U.S. has proposed that AMT (currently excluded from the scope of the Recommendation) be included.

Middle C-Band (5091-5250 MHz)

Current Use: 5091-5150 MHz is the primary AMT Band for all regions. 5150-5250 MHz is an AMT band in ITU Region 1 (Europe).

Spectrum Threat(s):

ITU. 5091-5150 MHz is the only globally harmonized band allocated for aeronautical telemetry world-wide. As a relative new AMT band, it has not been widely adopted except in ITU Region 1 (France) and Region 2 (the U.S. where its use is largely limited to military installations). Global

telemetry users are encouraged to make use of this AMT band. AMT use may need to co-exist with airport ground communications depending on the administration.

Upper C-Band (5925-6700)

Current Use: The ITU has identified this band for AMT in portions of ITU Region 2. Thus far, the US FCC has declined to take any action on AMT assignments in this band.

Spectrum Threat(s):

Unlicensed Wi-Fi: The FCC concluded 5925-7125 MHz could be utilized for unlicensed Wi-Fi and very low power devices for high data rate applications, such as wearables, augmented-reality and virtual-reality. The band is also used by point-to-point microwave links; terrestrial microwave operators (mainly public safety and utilities) which unsuccessfully opposed the FCC's Wi-Fi plans. While the FCC has tabled any AMT assignments/allocations in the band, DoD has studied spectrum aggregation technologies that could enhance AMT compatibility with incumbent systems.

CONCLUSIONS

Telemetry practitioners are encouraged to engage with their corporate management and national administrations to ensure their encroachment concerns are addressed. The International Consortium for Telemetry Spectrum is dedicated to serving the professional and technical interests of the telemetering community in this endeavor.

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