INTERNATIONAL CONSORTIUM
FOR TELEMETRY SPECTRUM

2016 ICTS Annual Report

Submitted by the ICTS Officers:

Mr. Mikel R. Ryan (USA), Chairman
Mr. Darrell Ernst (USA), Vice-Chairman
Mr. Tim Chalfant (USA), (Acting) Secretary

Regional Coordinators:

Dr. Gerhard Mayer (Germany), Region I Coordinator
Mr. Mikel R. Ryan (USA), Region II Coordinator
Mr. Darrell Ernst (USA), (Acting) Region III Coordinator

ICTS Meetings & Sessions

The ICTS held Business Meetings and General Sessions in October 2015 (Las Vegas, USA) and in May 2016 (Nürnberg, Germany). In Las Vegas, as part of the 2015 International Telemetering Conference (ITC 2015), ICTS Vice-Chairman Mr. Mikel Ryan (due to lack of travel funds ICTS Chairman Mr. Ghnassia could not attend) prepared and conducted the ICTS General Session (29 participants). After his welcome and introduction the *"Regional Reports of International Telecommunication Union (ITU)-Region 1-Europe/Africa* (Mr. G. Mayer of Germany), *ITU-Region 2/The Americas* (Mr. M. Ryan and Mr. S. Penna) *and ITU-Region 3-Asia/Pacific* (Mr. D. Ernst)*"* were presented, followed by briefings on *"The U.S. Flight Test Perspective on the 2015 World Radiocommunication Conference"*(Mr. K. Keane of the USA), *"How Brazil's ANATEL is Dealing With New Potential Threats to Telemetry Spectrum"* (Mr. L.F. de Souza of Brazil, *"Encroachment Threats to Aeronautical Telemetry in the USA: Update #11"* (prepared by Mr. S. Hoschar, presented by Mr. M. Ryan, both of the USA), *"The Potential for Aeronautical Mobile Telemetry in the Ku-, K- & Ka-Bands"* (Mr. G. Mayer of Germany, and *"C-Band Status and Future Wireless Needs at Airbus"* (Mr. G. Freaud of France).

Due to continuing USA Government budget cuts only one of the USA's ICTS Members (see ICTS Membership List below) were able to participate on-site at the May 2016 Nürnberg Sessions. Still, the session was a success, with a distinguished list series of presentations (some prepared by USA ICTS Members) and an involved audience (20 participants). ICTS Vice-Chairman Mr. Mikel Ryan prepared and conducted the ICTS General Session as part of the European Telemetry & Test Conference (ETTC 2016). After his welcome and introduction the ITU Regional Reports of *"ITU Region 2-Europe/Africa"* (Dr. G. Mayer) and *"ITU Region 2-The Americas"* (Mr. M. Ryan) were delivered, followed by briefings on "*Encroachment Threats to Aeronautical Telemetry in the USA: Update #12*" (prepared by Mr. S. Hoschar, presented by Mr. M. Ryan, both of the USA), *"Coded Orthogonal Frequency Division Multiplexing (COFDM) Standardization"* (Mr. S. Penna of Brazil), and *"Resolutions of the World Radiocommunication Conference 2015"* (by Mr. K. Keane of the USA).

Note that at the ITC 2015 in Las Vegas ICTS Officer elections were conducted during the Business Meeting, results below.

ICTS Membership

- Chairman/Region 2 Coordinator – Mr. Mikel Ryan (USA/Patuxent River MD) of Pacific Architects and Engineers Incorporated until his retirement in June 2017.
- Vice Chairman – Mr. Darrell Ernst (USA/Leesburg VA) of ErnsTek acting until his retirement in September 2016.
- Secretary (Acting) – As Mr. Holtmeyer retired in September 2014. Mr. Tim Chalfant has volunteered to shoulder this responsibility.
- Region 1 Coordinator – Dr. Gerhard Mayer (Germany) of the University of Salzburg.
- Region 3 Coordinator – Position Vacant, Mr. Darrell Ernst (USA/Leesburg VA) acting until his retirement in September 2016.
- Mr. Jean Claude Ghnassia (France) Head of Instrumentation for Airbus (retired).
- Mr. Steve Lyons (United Kingdom), QinetiQ Group.
- Mr. Luiz Fernando de Souza (Brazil) of Embraer Sociedade Anônima.
- Mr. Sergio Penna (Brazil) of Embraer Sociedade Anônima.

- Mr. Ken Keane (USA/Washington DC) of Duane-Morris LLP.
- Mr. Eric Prescott, Engineering Manager for Flight Test Instrumentation at BAE Systems Inc. (retired), currently a Telemetry Consultant for Nprime.
- Mr. Ray Faulstich (USA/Patuxent River MD) of Pacific Architects and Engineers Incorporated.
- Mr. Scott Hoschar (USA/Patuxent River MD) of the Naval Air Warfare Center Aircraft Division NAS Patuxent River.
- Mr. Tim Chalfant (USA/Lancaster CA) of the Air Force Test Center Edwards Air Force Base. Retirement eligible in June 2017.

We have currently good but declining membership numbers from ITU Regions 1 and 2. ICTS Members are getting the message out to the international community through the IFT, the International Test and Evaluation Association, and the Society of Flight Test Engineers. Besides the before-mentioned biannual Sessions, ICTS Members regularly offer papers at related Working Groups, technical conferences, trade journals and newsletters that bring the ICTS and its mission forward.

Results of the 2015 World Radiocommunication Conference (WRC-15) Agenda Items (AI) Impacting Aeronautical Mobile Telemetry (AMT): The USA Perspective

The 2015 World Radiocommunication Conference took place in Geneva Switzerland from 2-27 November. (Mr. K. Keane, who furnished this summary, represented the DoD's Test Resource Management Center [TRMC] in Geneva). The TRMC's principal objective for the Conference, protection of the USA's use of the L-Band for AMT as against identification for IMT by other administrations was secured. In particular, the objective was to protect RR 5.343, the AMT priority footnote for ITU Region 2.

While the Russian Delegation was successful in blocking our proposal for **No Change** ("NOC") to RR 5.343 from being elevated to one of the higher groups for inclusion in the Final Acts, our NOC proposal served its purpose: To cement the compromise worked out with other Inter-American Telecommunication Commission (*Comisión Interamericana de Telecomunicaciones* [CITEL]) delegations. (CITEL is an entity of the Organization of American States. Its job is to coordinate telecommunications-related positions of the OAS Member States. We agreed to identification of the band 1427-1518 MHz for IMT in ITU Region 2 while CITEL agreed to the NOC on RR 5.343. In addition, the USA insisted on language for the CITEL position as follows: *"In the United States, the 1 435-1 525 MHz band is used extensively for Aeronautical Telemetry (AMT); consequently, the United States has no intention of implementing IMT in the 1 427-1 518 MHz band"* (Addendum 3 to WRC Document 7(Add.1)-E, at page 2). No changes to RR 5.343 were made during the Conference.

With the footnote remaining intact, we will be in a good position going into the bi-lateral negotiations regarding protection of U.S. AMT operations concerning IMT use with Canada and Mexico (possibly Cuba too) that will follow in due course. This would be similar to other bi-lateral negotiations which have protected U.S. AMT, like the 1998 agreement which protected 1452-1492 MHz AMT and Canadian terrestrial broadcasting in the same band.

The other objective was protection of Recommendation ITU-R M. 1459 against proposals to adopt a pfd level for Broadcast Satellite Systems (BSS) in the 1452-1492 MHz AMT band.

While the intent of such proposals was to protect IMT against BSS, any such pfd would be reflected in Table 21-4 of the ITU Radio Regulations, a Table which is applicable to all "Terrestrial Services," including AMT. Moreover, the pfd value initially suggested was significantly outside the pfd limit specified by the Recommendation for BSS protection of AMT. We were successful in getting CITEL support for a proposal limiting any studies for a BSS pfd to ITU Regions 2 and 3 only, and this proposal was adopted. Hence, the outcome of any such studies will be limited to those Regions. The vast majority of U.S. ranges are of course in ITU Region 2.

WRC-19 Threats to AMT and Proposed Response: The USA Perspective

For WRC-19, several potential 'AMT impact' topics are being proposed. Issues being monitored include a proposal for a new Recommendation/Report dealing with IMT emissions in the 2170-2200 MHz band, implications for DISH agreement (out-of-band-omissions concerns with proximity to the 2200-2290 MHz AMT band), additional allocations for Radio Local Area Networks in 5 GHz (Interference with 5091-5150 MHz), and Non-Geostationary Satellite Orbit operations in 4/6 GHz (priority item), and BSS service in the 1452-1492 MHz band for ITU Regions 1 and 3.

The ICTS needs to maintain good communication in the international telemetering communities to protect IFT members who rely on these bands. The USA, Australia, New Zealand, Canada and the United Kingdom are attempting to establish a Flight Test Working Group (FTWG) and a Spectrum Working group under the MTEP/5i structure. Mr. Chalfant is advising the Air Force Test Center's representative to the FTWG to cue up AMT Spectrum Encroachment. Mr. Chalfant prepared a briefing deck (with Mr. Keane's help) for a FTWG organizing meeting in September 2016 highlighting the ICTS, the WRC process and threats to AMT. At this time we have no further information on the SWG. The TRMC is the POC for Multinational Test and Evaluation Program (MTEP) involvement from the Ranges. 5i preparation will be critical to protect telemetering at the working group meeting in preparation for WRC-19. The ICTS needs to seek similar forums that include the other international telemetering organizations and corporations.

Results of the 2015 WRC-15 AIs Impacting AMT: The European Perspective

Four WRC-15 Resolutions (Res) impacting Europe's AMT electromagnetic spectrum and the final outcome are enclosed:

1. ***Res. 223*** *(Rev.WRC-15)* ***"Additional spectrum to the Mobile Service (MS) on a primary basis for International Mobile Telecommunications (IMT)";*** **(AI 1.1):**

    - **L-Band: 1427 – 1452 MHz** and **1492 – 1518 MHz** have been identified for IMT worldwide; **1452 – 1492 MHz** identified for International Telecommunications Union (ITU) Regions 2 (the Americas) and 3 (Asia/Pacific). In ITU Region 1 (Europe/Africa) some African and Middle-East Countries agreed, but there was **no support** by the European Conference of Postal and Telecommunications (CEPT)**.**

- **S- and C-Bands:** No change for the 2200 – 2290 MHz and 4500 – 4950 MHz bands.

2. ***Res. 418*** *(Rev. WRC-15)* ***"Use of the band 5091 – 5250 MHz by the Aeronautical Mobile Service (AMS) for telemetry applications"*** allows now a **global allocation inclusive** the **5150 – 5250 MHz sub-band**. Up to now that was only allocable in Region 1- countries and Brazil in Region 2. Annex 1 of the resolution defines the utilization criteria for AMT. Conditions of operations with respect to other band incumbents are defined by the modified footnotes No. 5.444B and 5.446C of Article 5 (frequency allocations).

3. ***Res. 114*** *(Rev.WRC-15)* ***"Review the use of band 5091 – 5150 MHz by the Fixed Satellite Service (FSS) ";*** **(AI 1.7).** WRC-15 agreed to maintain the FSS allocations for the Mobile Satellite Service (MSS) Feeder links (earth to space. That was in line with the European Common Proposals (ECP) of the CEPT.

4. ***Res. COM 6/16*** *(WRC-15)* **"Agenda Items for the WRC-19"**

   - 1.13 *"to consider identification of frequency bands for future development of IMT, inclusive additional allocations to the Mobile Service (MS) on a primary basis, in accordance with COM 6/20 (WRC-15)".*
   - 1.16 *"to consider issues related to the Wireless Access Systems/Radio Local Area Networks (WAS/RLAN) in the frequency band 5150 – 5250 MHz 5150 – 5250 MHz…in accordance with COM 6 / 22(WRC-15)".*
   - 9.1.8 *"Narrowband- and Broadband Machine Type Communication Infrastructures", in accordance with COM 6 / 1 (WRC-15).*

European Conference of Postal and Telecommunications Administrations (CEPT) Activities after the WRC-15

(CEPT is 48 European counties cooperating to regulate posts, radio spectrum and communications networks.) During its 41st Plenary Meeting (Ghent, 1-4 March 2016), CEPT's European Communications Committee (ECC, which considers and develops policy on electronic communications activities in European context, taking account of European and international legislations and regulations) made a number of decisions on spectrum use and developed responses to mandates from the European Commission in relation to various sectors: wireless broadband communications, wireless mobile communications on board vessels (MCV), Machine-to-Machine communications (M2M), Short Range Devices (SRD), Public Protection and Disaster Relief communications (PPDR), Program Making and Special Events applications (PMSE) and satellite communications.

As a follow up to the decision taken at WRC-15 where the frequency bands 1427-1452 and 1492-1518 MHz were identified for IMT, the ECC agreed to initiate studies for the introduction of mobile/fixed communication networks (MFCN) in these frequency bands and for assessing how to maintain flexibility. The objective is to develop relevant ECC harmonization measures in due time. The residual AMT L-Band operations in Europe detailed below remain in existence, protected by the RR Article 5 Footnotes:

Russian Federation and allied countries	1429 – 1535 MHz
Switzerland	1435 – 1445 MHz
United Kingdom	1427 – 1452 MHz

In the meantime, all other European countries have completely changed their AMT operations to the S- and C-Bands.

The ECC Project Team 1 (ECC PT1) responsible for implementing the *"Wireless Access Policy for Electronic Communication Services"* (WAPECS) concept (the new European flexible approach based on technology and service neutral regulation) for the MFCN, was tasked to initiate also studies for the introduction of MFCN in the L-Bands to investigate the suitability of the current ECC framework for future usage of LTE-based M2M communication.

The ECC, hosted by the Federal Network Agency, held a CEPT Workshop on Machine-To-Machine Communications (M2M) from 21-22 March 2016 in Mainz, Germany. 134 participants from national regulatory authorities, industry representatives, experts and professionals attended the workshop to discuss electromagnetic spectrum as well as numbering and addressing harmonization needs of existing and future M2M applications.

The aim of the workshop was to understand better the spectrum as well as numbering and addressing harmonization needs of existing and future M2M applications, since related initiatives are present in various fora within the ECC. It is intended to enable a general consultation and an exchange of views with the industry. This aim was fulfilled and the workshop identified a number of spectrum issues, and numbered and addressed issues for the ECC and its working groups to consider the need to work further on them and to revise their work programs as appropriate for on-going work items as well as new ones. We forecast M2M wireless traffic to quadruple within the 2015 to 2022 time frame. That will cause pressure for the commercial industry to more acquire additional unlicensed and individually licensed spectrum.

Future wireless applications as part of the 'Industry 4.0/Smart Manufacturing' and the 'Internet of Things (IoT)' lobbies would need at least additional 80 MHz of spectrum in the 1 – 6 GHz range. IMT 5th Generation Wireless (5G) spectrum as considered under AI Item 1.13 (WRC-19) with band options over 24 GHz may not be suitable for most applications. The requested band(s) will be specific for industrial applications and be globally available. That issue is strongly supported by the powerful and effective 'One M2M Partnership Project' lobby with more than 200 members worldwide.

Threats to AMT (European View)

1. S-Band 2300 – 2400 MHz:

This band was already allocated for IMT in some European countries on a non-interference basis with the primary services (MS/AMT, PMSE etc.) on the basis of Resolution 223 (Rev. WRC-12). The Licensed Shared Access (LSA) initiative carried out by the ECC Project Team's FM-53 (regulatory conditions for LSA) and FM-52 (implementation of LSA for the shared use of the band 2.3–2.4 GHz on a secondary basis) was concluding its activity (CEPT Report #56 on *"technological and regulatory options for sharing between WBB and the relevant incumbent services/applications in the 2,3 GHz band"* of 6 March 2015). With the

completion of these activities WG FM decided to create a new work item on the exchange of information on LSA implementation. The objective is to share experience on LSA implementation and testing (e.g., measurement results) between the national spectrum regulating agencies.

Information on national studies and tests are available from Finland, France, Italy and Spain. A pilot "5G Mobile Network Demonstration" supported by Italy, Finland, France (and their industrial partners), further by the Joint Research Centre of the European Commission started in January 2016 running over a six month period.

2. C-Band 5150 – 5250 MHz

WRC-15 Action Item 1.16 *"to consider issues related to the WAS/RLAN in the frequency band 5150 – 5250 MHz … in accordance with COM 6/22(WRC-15)"* does address studies in the frequency band 5150 – 5925 MHz related to Wireless Access Systems (WAS) inclusive Radio Local Area Networks (RLAN) applications with multimedia capability. This band was already allocated for that purpose but for indoor operations only. Now the above resolution invites commercial users *"to perform sharing and compatibility studies between WAS/RLAN applications and incumbent services in the frequency band 5 150-5 350 MHz et.al. with the possibility of enabling outdoor WAS/RLAN operations including possible associated conditions."*

3. C-Band 5150 – 5250 MHz Continued

The European broadband lobby (independent from AI 1.16 of the WRC-19) has firm plans to introduce Licensed Assisted Access (LAA)/Long Term Evolution (LTE) Advanced test operations from 2017 onward by applying their "Standard Advanced-Pro," that is, primary LTE cells operating in other bands will synchronize LTE secondary cells that operate in the bands 5150 – 5350 and 5470 – 5725 MHz.

Within our AMT band 5150 – 5250 MHz (now globally allocable since the WRC-15) five LTE channels with a bandwidth of 20 MHz each could operate on a power level of +36dBm and a power flux density of 17 dBm/MHz, respectively. They believe, that interference to the incumbent services (e.g. AMT) can be avoided by their proposed mode of operation ***"listen before talking"*** (!!!!).

4. Industry 4.0, Smart Manufacturing

Global Wireless Industrial Applications (WIA) in the process industries are still at the beginning of their growing phase (ref. CEPT M2M Workshop, March 2016):

WIA connected devices in year	2005	2012	2018 (predicted)
in millions	0,2	12	200

Existing wireless base technologies are not specifically designed for these industries. Distances up to 5 kilometers have to be covered in a high-quality service level: the presently used unlicensed bands at 2.4 & 5.8 GHz are insufficient, and European productivity is suffering from the constraints. The requested band(s) in the range 1 – 6 GHz shall be specific

for industrial applications with a bandwidth of (minimum) 80 MHz (or 2x40 MHz) and be globally available.

Candidate for studies are also the 2340 – 2400 & 5150 – 5250 MHz bands. The lobby of the "One M2M Partnership Project" attempted to by-pass the regular preparation process for the WRC-19 and succeeded. Their spectrum demand is now covered by AI 9.1.8: *"Narrowband- and Broadband Machine Type Communication Infrastructures"* in the ITU(R) *"list of urgent requirements in preparation of the WRC-19, Resolution 958 [Com 6/1] (WRC-15).* With studies by Working Party 5D they hope to bring their issue to a decision level at the WRC-19.

The global telemetry community is concerned about this rapidly-developing issue. Beside tracking and (if needed) trying to influence the preparation process for the WRC-19 a clear strategy to determine what conditions of coexistence with those intruding services could be tolerable is urgently required. Even with plausible mitigation techniques we have to evaluate how it could work in practice. Interference and noise levels in band, out-of-band emissions and spurious domains that are generated by the signals of those WIA services have to be recorded and analysed.

AMT Activities in the United Kingdom (UK)

The UK has ATM Allocations in the L-, S- & C-Bands, although L & S are both threatened:

1. L-Band: 1435–1452 MHz

It's unlikely that any new AMT spectrum allocations in L-Band will be granted but existing users, for now at least, continue to operate in the band. The band has been identified by the UK as a candidate for band sharing, and as the national commercial communications industry paying for its use would bring in much desired revenue it is likely that continued AMT usage of L-Band will at best be discouraged.

For some years Qualcomm has held the electromagnetic spectrum immediately above 1452 MHz for use with Mobile Phone Supplementary Data Link (SDL) services. That the Block Edge Model allows Out of Band Emissions below 1449 MHz of -20dB, SDL services haven't been a problem to AMT, largely because Qualcomm never made much use of this band. However, the Qualcomm spectrum allocation has recently been transferred to Vodafone (1452-1472 MHz) & Hutchinson (1472-1492 MHz), and as they reportedly paid over $300,000,000 it can be expected that they will soon start to use it with potential detrimental impact to L-Band AMT.

2. S-Band: 2310–2350 & 2350–2390 MHz

Due to commercial issues within the telecoms industry the long expected auction of the 2350–2400 MHz part of the 2310–2390 MHz band to 4G telecoms under UK Government's Public Sector Spectrum Release (PSSR) program has not yet taken place. Despite that, this part of S-band is generally no longer available for AMT with former users being moved elsewhere. The medium term expectation is that the remaining part of the band (2310-2350 MHz) will also eventually be lost for AMT, but meantime adopting ways to minimize the amount of bandwidth required whilst maintaining performance is being encouraged.

Missile Telemetry has traditionally used S-Band and the anticipated ongoing loss of the band indicates that Missile manufacturers may need to be considering alternative bands, especially the C-Band, since new missile lead-time is lengthy.

3. C-Band: 5091–5150 & 5150–5250 MHz

C-Band has significant bandwidth plus authority to transmit in the band is anticipated to be readily available. However, to date cost, performance issues (e.g. tracking & range) and long lead-times have resulted in minimal C-Band AMT usage in the UK, although that is anticipated to change as new programs require spectrum that is no longer available in the L- & S-Bands.

One worrisome trend in the UK is the ongoing pressure by the commercial sector for AMT to vacate S-Band. A potential consequence that would be of which is that a next generation missile may appear equipped with only S-Band AMT with the result that it either can't be tested in the UK or would require a costly/lengthy modification program. Alerting missile manufacturers now could address the problem before it becomes a reality. Whilst this is the state of the UK today this issue could visit other countries soon. And if the ICTS doesn't raise awareness, protect and advocate for international AMT users, who will?

Threats to AMT from WRC-15 Agenda Items: The Brazilian Perspective

L-Band:

At WRC-15 the band 1427–1518 MHz is identified for IMT, but in Brazil has been operating AMT in the 1452–1472 MHz L-Band since 2005. However, Anatel will identify a 20 MHz-wide Brazilian AMT band that shall remain inside the 1435–1525 MHz range. Still, chances are this AMT band it will be eventually shifted from 1452–1472 MHz in order to accommodate the supplementary downlink of the IMT.

S-Band:

Until 2017 AMT is temporarily allocated in the 2230–2260 and 2330–2360 S-Bands. These are now the most heavily-used AMT bands in Brazil.

C-Band:

At the most recent International Civil Aviation Organization Frequency Spectrum Management Panel **(**ICAO FSMP) Meeting (February 2016) the draft version of the AeroMACS was presented. The text extract below shows the chapter:

FREQUENCY ALLOCATION AND CHANNELIZATION

AeroMACS operates in frequency bands allocated – either on a national or international basis – to the aeronautical mobile (route) service (AM(R)S). As a result, AeroMACS is restricted to supporting communications related to safety and regularity of flight. In addition, in accordance with International Telecommunications Union (ITU) Radio Regulations, AeroMACS is limited to supporting surface applications at airports.

By definition communications in the AM(R)S are limited to being between aircraft and ground stations, or between aircraft. In ITU however the precedent exists that local area networks (like AeroMACS) operating in frequency bands allocated to a mobile service (like AM(R)S) can support both mobile and fixed/nomadic (i.e., low mobility) applications. As a result, some States plan to utilize AeroMACS also for airport surface communications between ground stations. Finally, some States allow limited use of AM(R)S frequency bands (and by extension AeroMACS) by non-aircraft vehicles; in particular vehicles such as snow plows which may mix with aircraft on the airport movement area.

AeroMACS equipment can tune across the band 5000 MHz to 5150MHz, in 250 kHz steps with reference channel of 5145 MHz. That reference channel is used to identify a channel whose center frequency is included in the list of center frequencies that are to be tuned by AeroMACS, and it is a reference point for the identification of all other center frequencies that may be tuned by AeroMACS using the channel step size.

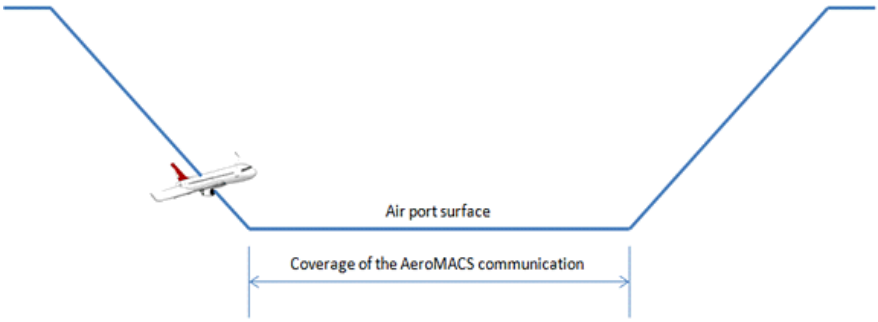
The core AeroMACS band is 5091-5150 MHz, however channels can also be assigned in the sub-bands 5000-5030 MHz based on national regulations, and 5030-5091 MHz depending on frequency planning defined at ICAO level considering other Aeronautical applications. The 250 kHz step size will allow AeroMACS to gracefully move away from any interference source such as microwave landing systems (MLS), Aeronautical Mobile Telemetry (AMT), or Military users operating in the 5000-5150 MHz band.

Due to its limitation to surface transmissions, it is expected that in most cases all AeroMACS channels will be available at all airports (i.e., airport-to-airport coordination is not expected to be necessary). It is also expected however that not all airports will have sufficient communications requirements to necessitate use of all the AeroMACS channels.

One constraint on AeroMACS that was considered during the development of the AeroMACS standards is ensuring compatibility with satellites that share the operating frequency band. While those standards were developed using worst-case assumptions, compatibility with the satellites can be enhanced by, for airports which do not require use of all the channels, distributing actually-assigned channels across the band. In order to ensure uniformity in that distribution, it is expected that a central authority in each State will control AeroMACS assignments.

Further detail on AeroMACS channel assignment criteria and constraints are under development by ICAO. When completed they will be included in Annex 10 Volume V.

AeroMACS is for communication on the airport surface only. Although aircraft on the approach and departure phase of the flight may receive AeroMACS signals while on flight as shown by the glide slopes in Figure 1, aircraft is not permitted to transmit one AeroMACS bands while in flight. Airport systems should be designed to reduce sky-ward emissions through appropriate placement and orientation of the AeroMACS antennas.



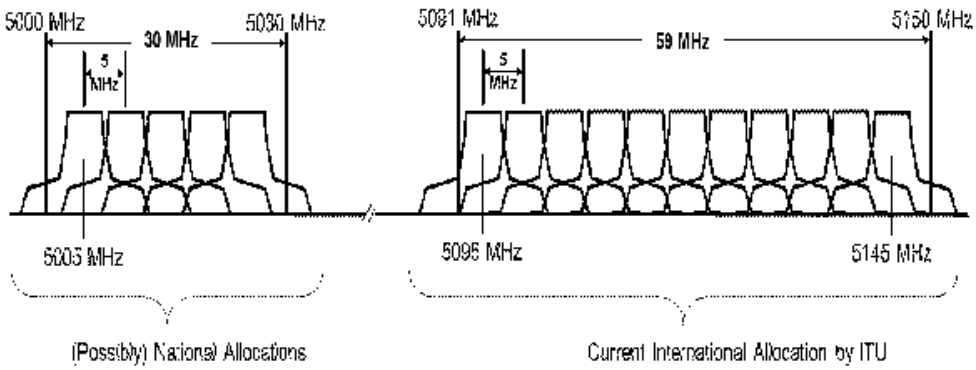
AeroMACS radio communication entities use 3 types of bands which are limited to use with surface communications at airports.

- Primary band : 5091 – 5150 MHz (International table of frequency allocations)
- Secondary band : 5000 – 5030 MHz (National allocations)
- Tertiary band : 5030 – 5091 MHz (Depending on frequency planning defined at ICAO)

All AeroMACS Channels have 5 MHz bandwidth, and each bandwidth can be allocated to start in a unit of 250 kHz. Frequency planning is required to insure that the 5 MHz channels do not overlap.
The Primary band can use a maximum of 11 channels at a location. The primary channel center frequencies are allocated at 5095, 5100, 5105, ..., 5145.

The Secondary band can use a maximum of 5 channels at a location. Center frequencies of the secondary channel are allocated at 5005, 5010, 5015, …, 5025.

Tertiary band also is determined the center frequencies at the same policies of the above bands.



For the ICTS, it is most important to know whether there is already an arrangement in progress between a regional telecommunication agency and an AMT user (Airbus, Dassault, Eurocopter, Boeing) for coexistence of AeroMACS and AMT in C-Band.

For Embraer, there is a potential threat if the experimental operation of AeroMACS at the Viracopos International Airport (near Campinas City some 150km northwest from São José dos Campos) becomes a reality.

The Potential for AMT in the Ku-, K- & Ka-Bands

A possible tasking for the ICTS involves investigating the feasibility of augmenting our current international AMT bands. We have no current spectrum allocations for AMT in the Ku-,K-and Ka-Band range (20–36 GHz), but we should actively, expeditiously determine whether we may need frequency spectrum in that range in the future, year 2020 and beyond.

Dr. Michael Rice's (USA, Brigham Young University) notable *"Aeronautical Telemetry Above 15 GHz: A Feasibility Study"* of December 2014 demonstrates that the market-available components and systems for the Ku-, K- and Ka-Bands are capable of accommodating some of our AMT needs. The biggest challenge to our community is the propagation issue, but methods to compensate for any loss of the link margin were identified in Dr. Rice's study. Also, the considerable regulatory challenge in securing an allocation in these bands is addressed by Dr. Rice: *"All of spectrum in these bands has been assigned by the USA's Federal Communication Commission (FCC) and the National Telecommunications and Information Administration (NTIA), and the incumbents would try to enthusiastically protect their assignments."*

In case of a need for additional AMT bands (to augment the currently allocated L-, S- and C-Band portions), the K- and Ka-Bands were already identified as promising candidates in 2008. A pilot project to demonstrate the capabilities of Ka-Band telemetry transmission was proposed in Europe and is under further study. The Test Range in Manching Germany is a candidate for the first flight tests.

The International Mobile Telecommunications (IMT) 5th generation mobile/wireless networks (5G) lobby intends to study their possible use of bands in the range 6-100 GHz, with related AIs proposed for the WRC-19. In particular, the METIS 2020 Research Project is being partially funded by the European Commission with an eye toward enabling its vision of the 5G future. Nearly one year after its November 2012 creation, METIS has laid out wireless scenarios that it hopes to address and specified the capabilities it expects of 5G networks. Note that portions of K-and Ka-Band are conspicuously targeted so the Telemetry Community needs to quickly decide if this is an applicable, profitable assignment for the ICTS. If so, we need to first decide:

-Is there a need for additional spectrum for AMT, time horizon 2020 and beyond, or not?

-If so, what kind of test missions needing point-to-point or networked telemetry, could live with the physical limits of the K- and Ka-Bands?

If the answers are satisfactory we should seek possible parts of those bands where a co-primary base allocation for AMT is possible, preferably in all three ITU Regions. A cursory examination of the ITU Radio Regulations (Edition 2012, Article 5) reveals that bands from 25-29.5 GHz and 31-31.3 GHz are listed for allocation to the Mobile Service (MS), on a non-interference base to other incumbent services.

Adding urgency to this issue is WRC-19 Action Item 1.13 *"..to consider identification of frequency bands for future development of IMT… invites to conduct sharing and compatibility studies for the band 24,25 -27,5 GHz, 31,5 – 33,4 GHz et. al."* The Ka-Band is a favourite candidate for future AMT extension requirements within the time horizon 2020 to 2025, a demand was already predicted by the "15G-Study Group" charted by the USA's Department of Defense's Test Resource Management Center (DOD/TRMC). Studies to investigate future AMT spectrum demand are under regional work now. The intentions of the IMT world to acquire additional spectrum in the K-and Ka band range should alert the telemetering community to quickly ponder about the requirements for additional spectrum, within a time horizon 2020 and beyond. At a later time point it will be much more difficult (or worst case with almost no chance) to initiate that process.

Given the time constraints in terms of developing proposals for agenda items for WRC-19, and the fact that the USA itself has not yet implemented all of the AMT spectrum allocated at WRC-07, among other factors, any proposal for additional AMT spectrum would be subject to close scrutiny by U.S. spectrum regulators and, unless advocated by other administrations, is not likely to be on the agenda for WRC-19.

An Uncertain Future for the ICTS

As detailed in previous Annual ICTS Reports, the lack of financial support and erosion of the ICTS membership via retirement (see the **ICTS Membership** Listing in page 2) is crippling the ICTS. Although incessant international threats to our current AMT bands abound and WRC-19 coming up, due to a continuing prohibition on "unnecessary" international travel even national travel, our diminishing ranks cannot attend the national WRC preparation meetings, and we are losing the personal contacts and the ability to advise the national WRC representatives. (A commendable exception is TRMC funding for Mr. Keane's and Dr. Dan Jablonski's WRC-involved activities.) AMT spectrum is continually threatened with band reallocation and reductions in bandwidth, and we believe the mandate to defend our current electromagnetic assets and seek new AMT frequency bands means that there is as much a need for an organization with the objectives of the ICTS as there has ever been.

But how do we recover, presuming recovery is possible? Recent, candid suggestions by the ICTS membership include:

1. Perhaps convert the ICTS to a standing IFT committee like the Telemetering Standards Coordination Committee (TSCC), with no real outreach efforts. The meetings would occur in a similar manner.
2. Perhaps eliminate the ICTS's Regional Coordinators, assuming there is a need or better way to collect information from around the globe.
3. Perhaps change the ICTS to a collection of National "CTSs" and work domestic issues with the active members. However, we don't believe the ITU threats to

AMT are over . . . until they find a way to create more spectrum below 3G, AMT will be at risk globally.

At the upcoming 2016 International Telemetering Conference the ICTS membership will meet, as feasible, to take stock of our dilemma.

Conclusions

The main objective of the ICTS is to provide a forum for information exchange on telemetry spectrum issues. In addition this forum will be used to share information on the use and research and development of new technologies for improving spectral efficiency.

Ideally, the ICTS would continue to be the *"eyes and ears"* for the IFT/AMT community with regards to international spectrum threats and issues. The significant impact and success of our past work should be evident from this and past ICTS Annual Reports and the ICTS general sessions of the ETTC and ITC. However, our work is handicapped by a lack of travel funding and the loss of experienced, dedicated, articulate, internationally recognized and respected spokesmen. The "I" in ICTS, IFT & ITU stands for "International" so the Conferences, the negotiations, and the voting that will decide the fate of our AMT bands are conducted in necessarily widespread locales.

The importance of having on-call, immediately accessible AMT experts to amplify and clarify complex telemetry spectrum issues for delegates has been confirmed numerous times. It would be advantageous to the AMT Community to attend the relevant Study Group ITU Working Parties (WP) 4 & 5 for the preparation of the WRC-19. meetings where the critical agenda points with potential to threaten AMT spectrum are under discussion. After all, WRC-07, WRC-12 and WRC-15 conclusively demonstrated that voting delegates to ITU Study Groups can be made sensitive to our encroachment concerns by ICTS Members.