INTERIM MEETING OF THE IARU REGION 1 VHF/UHF/MICROWAVE COMMITTEE
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Subject	Increased Amateur-Satellite Service 144MHz Usage
Society	RSGB
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Status	Proposal

Introduction

At the meeting of IARU Region-1 held in Cavtat in 2008, the RSGB proposed the possible shared use of the lightly-used bottom end of the 144-146MHz band by linear transponders in the amateur-satellite service.

At Cavtat a decision was made to remove the EME-exclusive designation of the bottom 35kHz section, although the satellite-usage aspect failed to gain acceptance at the time. Since then, additional evidence of the need and support for the concept has been obtained, in order to enable this innovative and growing usage.

Current Use

The Amateur-Satellite Service has, according to the ITU Radio Regulations, access to the full allocation of 144-146MHz but, by agreement of all three IARU Regions, currently only uses a sub-section of the allocation on an exclusive basis - namely 145.80 – 146.00 MHz.

It is presently used for both satellite uplinks and downlinks although the Cavtat Conference agreed to recommend its use for downlinks-only to reduce QRM from non-amateur signals being relayed if it used for uplinks. It is the most popular of the Amateur Satellite allocations for the following reasons:-

- It is the only band between 29.7 MHz and 24 GHz where we have Primary use and hence some control. The 435 MHz, 1.26, 2.4, 5.6, 5.8, and 10 GHz amateur satellite bands are all shared with either high power users (eg Primary radars), or large numbers of consumer devices which raise the noise floor.
- 144 MHz is the most efficient band for amateur satellite downlinks due to the relative ease and efficiency of on-board RF power generation and reduced path losses (9dB better than 437MHz).
- Receiving equipment is widely available. This is an important consideration in many countries where Amateur Satellites are seen as an important tool in encouraging young people to pursue technical self-training.
- Ready availability of launch opportunities where size constraints mean Attitude Control is often not possible. The lack of attitude control mandates the use of simple omni-directional antennas. This in turn means the use of VHF due to the lower path losses.
- The current 145.8-146 MHz section of the band is presently quite heavily used by Amateur Satellites. In addition, on the International Space Station, there is an Amateur Packet Repeater, and Voice operations from the Amateurs onboard also taking place in this narrow segment.

As at October 2011, there are 15 amateur satellite systems currently actively using the 144MHz band for either uplinks or downlinks (See Annex). They are all in low earth orbit and so are above the horizon for a maximum of about 15 mins per orbit. Depending on the ground station's latitude, these passes will occur 4 or 5 times per day.

Future Use Requirements

An area that has been growing rapidly has been the development of Amateur Satellites by university students. Already, large numbers of students have been involved in developing Amateur Satellites. This growing activity is beneficial to both the students and the wider Amateur community. The students of today are becoming our successors and supporters of tomorrow.

A large number of both pure amateur radio, and dual-purpose amateur/educational spacecraft, are presently being developed and some are scheduled for launch during 2013.

An increasing tendency is for multiple Satellites to be carried by a single launch. The annex lists one such imminent launch scheduled for 2013, which is expected to deploy seven additional spacecraft, which will use the 145 MHz allocation.

The annex also lists several other planned satellites due in 2013 or shortly afterwards, demonstrating that the utilisation is growing. It can also be anticipated that additional and unexpected launch opportunities may occur.

There is therefore a need for an additional Satellite segment at 144 MHz that could be used for linear transponder downlinks for CW/SSB operation. This would free-up capacity in the current 145.8-146MHz segment to better accommodate FM/data modes.

Given that these linear transponders might have a bandwidth of between 20 and 30 kHz, the use of a segment approximately 35 kHz wide would be required to allow for Doppler shift, which can be as great as +/- 3 kHz. This activity would be restricted to satellites in Low Earth Orbit, so that signals would not be present for extended periods.

Background Research

In 2008 it appeared that very little EME was then taking place at the very bottom of the 144MHz band, due to interference from computer oscillators. This section is already aligned worldwide and therefore it was considered that this could be a suitable part of the band to be used. More recent research and discussions suggest that this situation remains the same today.

Further research has concluded that the bottom 35 kHz of the 2 metre band is almost completely unused. However it is recognised that, in Region-1 at least, occasional brief terrestrial usage does occur - for instance during the IARU Region-1 CW contest (November), and when large scale auroral and tropospheric openings are underway.

The concept behind this proposal has also been presented and discussed at various IARU International Satellite Forums that have taken place since 2007, and has received full approval from the representatives who have been in attendance.

It is noted that some existing regional and national band plans restrict transmitted bandwidth to 500Hz or to CW-only; however the reception of signals from these transponders would not be affected by this restriction.

In mitigation it might be considered that the satellite band plan should have the CW portion at the top end of the proposed spectrum to aid compatibility with possible terrestrial operation in the proposed
144.000-144.035 section.

Recommendations

- To permit those satellites which are launched into Low Earth Orbit, operating in the Amateur-Satellite Service, and which incorporate narrowband "linear" transponders, to use, on a
  non-exclusive basis, the 144.000 –144.035MHz section of the 2 meter band for down-link (satellite-to-ground) mode only.

- To accommodate the above by amending the existing 2 metre band plans in each IARU Region. This will enable more efficient accommodation of FM and data use at 145.8-146.0 MHz and also enable us to improve the spectrum efficient utilisation of our 144 MHz band.

- As an aid to compatibility to coordinate SSB from linear transponder operation to the lowest part of the new 144 segment (towards 144.000); and that CW be positioned at the upper end (near 144.035).

Annex: 144MHz Amateur Satellites

Currently active in the 144MHz Band

Satellite / Callsign	Object	Uplink	Downlink	Beacon	Mode
AO-7	07530	432.125-175	145.975-925	145.970	B,C
UO-11 (UoSAT-2)	14781	-	-	145.826	Beacon
AO-27 (EYESAT-A)	22825	145.850	436.795	436.795	1200bps AFSK,FM
FO-29 (JAS-2)	24278	145.900-999	435.900-800	435.7964	SSB,CW
NA1SS/ISS	25544	145.825	145.825	145.825	APRS
NO-44 (PCsat1)	26931	145.827	145.827	145.827	1200bps AFSK
SO-50 (SaudiSat-1c)	27607	145.850	436.795	-	FM_tone 67.0Hz
VO-52 (Hamsat)	28650	435.225-275	145.925-875	145.860	SSB,CW
PCSat2		145.825	435.275	437.975	9600bps FSK
DO-64 (DELFI-C3)	32789	-	145.870	145.8675	1200bps BPSK
TIsat-1	36799	145.980	437.305	145.980	FM,AFSK,PSK,CW
FO-70 (FASTRAC-2)	37380	435.025	145.825	145.825	1200bps AFSK
Xatcobeo	38082	-	145.940	437.365	1200bps FFSK,SSR,CW
PW-Sat1	38083	435.020	145.900	145.902	1200bps BPSK,FM,CW
PRISM	33493	145.xxx	437.425	437.250	1200bps AFSK

Amateur Satellites expected to be active in the 144MHz Band

Imminent: (in a single launch)

- **FUNcube-1** - Transponder uplink 435.150-435.130MHz downlink 145.950-145.970 MHz and beacon 145.935MHz (Netherlands)
- **FirstMOVE** - Telemetry downlink 145.970MHz (Germany)
- **Velox P11**- Telemetry downlink 145.980 MHz (Singapore)
- **Triton 1** - Telemetry and DSB transponder downlinks 145.815 MHz and 145.860MHz (Netherlands)
- **Delfi-n3Xt** - Transponder uplink 435.130-435.150 MHz downlink 145.880-145.970 MHz & Telemetry and DSB transponder downlinks on 145.870 MHz & 145.930MHz (Netherlands)
- **PUCPSat** - Telemetry downlink 145.840MHz (Peru)
- **Icube-1** - Telemetry and DSB transponder downlink 145.947 MHz (Pakistan)

Planned for later in 2013:

- **UKube-1** – Linear transponder downlink 145.930-145.950 MHz, telemetry downlinks on 145. 915 MHz & 145.840 MHz (United Kingdom)
- **KiwiSat** – FM voice transponder& telemetry downlink 145.865MHz & linear transponder downlink 145.850 -145.880 MHz (New Zealand)
- **FOX-1** – FM transponder downlink 145.xxx MHz (USA) – Amsat-NA

Also Planned:

- **ESEO** – DSB transponder downlink 145.xxxMHz (ESA)
- **CAS-2** - CW telemetry beacon 145.990 MHz, AX.25 digital telemetry beacon & voice beacon 145.815MHz, Linear transponder downlink 145.850 -145.900 MHz, (China)
- **Nanosatc-BR2** - Telemetry and DSB transponder downlink 145.865MHz (Brazil)
- **DynaCube** – Telemetry downlinks on 145.840 & 145.980MHz (South Africa)
- **MaxValier** - Telemetry downlinks on 145.860 & 145.960MHz (Italy)
- **Duchifat-1** -APRS downlink 145.825MHz plus DSB transponder downlink 145.980 MHz (Israel)
- **CAMSAT BUAA-SAT1** - FM voice transponder downlink 145.875 MHz, telemetry downlink 145.950 MHz and CW beacon 145.835MHz (China)