Amateur / RNSS Coexistence in the 23cm band

- Barry Lewis G4SJH
- IARU Lead on WRC23 AI9.1b
- IARU Interim Conference – June 2022
23cm Band and Radio Navigation Satellite Services

- CEPT Study Program is considering Galileo (EU).
- ITU-R Study Program as above plus GLONASS (R.Fed), COMPASS (China) and QZSS (Japan).
- Considering Technical and Operational measures to protect RNSS services.

Regulatory Status for the Amateur Services allocation in the ITU-R Radio Regulations

- 1240 – 1300MHz is allocated to the RNSS on a primary basis across all 3 regions.
- 1240 – 1300MHz is allocated to the amateur service (AS) on a secondary basis with 1260-1270 MHz also allocated by footnote to the amateur satellite service (ASS) also effectively on a secondary basis both across all 3 regions.
- Stations of a secondary service:
  - 5.29 a) shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date;
  - 5.30 b) cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned at a later date;
  - 5.31 c) can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date.
The RNSS systems within the scope of studies

<table>
<thead>
<tr>
<th>RNSS System Bands</th>
<th>1256.29 (Galileo)</th>
<th>1257.76 (QZSS)</th>
<th>1278.79 (Galileo)</th>
<th>1299.21 (QZSS)</th>
<th>1299.75</th>
</tr>
</thead>
</table>

- **GLONASS L2 Sig Block**
- **COMPASS D3 Sig Block**

**IARU Band Plans**

- **R1**: ATV Block
- **R2**: ATV Block (Exp)
- **R3**: All Modes

- Broad bandwidth modes
- Satellite uplink priority all regions
- Medium bandwidth modes <20 kHz
- Wider bandwidth modes <150 kHz
- Narrowband modes <3 kHz

23/06/2022
Barry Lewis G4SJH; IARU Global lead on WRC23 Al 9.1b
Additional challenges for the amateur service

• Amateur operations are co-frequency almost everywhere in the band.
• Amateur station operators do not know where or when an RNSS user is active.
• An RNSS user will most likely be unaware that interference is occurring.
• New “High Accuracy” services under development with commercial ambitions.
• Widespread deployment of RNSS receivers.
Technical Studies

• Propagation Model predictions to estimate the distance over which harmful interference could be caused to an RNSS receiver.
  • Harmful interference is that which exceeds the RNSS protection criteria in the relevant ITU-R Recommendation.
  • GALILEO Protection criteria (M.1902) = -134dBW for narrowband emissions (<128kHz) and -140.5dBW/MHz for wideband emissions (>1 MHz) at the receiver input.

• Conducted measurement programmes assessing the impact of various amateur radio application emissions on the RNSS receivers.

• Interference case study.
Propagation Model Estimates

- ITU-R model ITU-R P.1546 used based on sets of typical amateur station parameters and RNSS receiver deployment scenarios.
- Performed mainly by France (on GALILEO) and China (on COMPASS).

100W amateur narrowband transmitter (50% Locations for 1% time)

- In this area the RNSS protection criteria is exceeded
- 26km
- 10km

Wideband
Narrowband
13km
Measurement campaign – EC JRC (3 receivers)

**Narrow-band emissions**
- Morse, Bandwidth < 1KHz,
- Narrow Band FM, 15 KHz bandwidth,
- Digital Transmission (dStar), 128 KHz bandwidth,

**Wide-band emissions**
- DVBT2 with 1.7 MHz bandwidth
- DVBT2 with 10 MHz bandwidth.

**Frequencies according to IARU Band Plan:**
- Morse: 1296.2 MHz
- Narrow Band FM: 1297.5 MHz
- Digital Transmission (dStar): 1299.2 MHz
- DVBT2: 1280 MHz

**Frequencies relative to the E6 centre freq (1278.75MHz)**
- $\Delta F = 0$ MHz
- $\Delta F = 5.115$ MHz
- $\Delta F = 20.46$ MHz
- $\Delta F = 23.0175$ MHz

23/06/2022
Barry Lewis G4SJH; IARU Global lead on WRC23 AI 9.1b
EC JRC - Results

In accordance with band plan – JRC “Receiver C”

<table>
<thead>
<tr>
<th>Application</th>
<th>Centre Frequency</th>
<th>Bandwidth</th>
<th>Power at antenna input resulting in 1 dB C/N0 degradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Telegraph</td>
<td>1 296.2 MHz</td>
<td>&lt; 1 kHz</td>
<td>-130.5 dBW</td>
</tr>
<tr>
<td>3 NB-FM</td>
<td>1.2975 MHz</td>
<td>11.1 kHz</td>
<td>-126 dBW</td>
</tr>
<tr>
<td>4 Digital Data 128 kBit/s</td>
<td>1 299.2 MHz</td>
<td>128 kHz</td>
<td>-124.5 dBW</td>
</tr>
<tr>
<td>5 DVB-T2</td>
<td>1280.0 MHz</td>
<td>1 MHz</td>
<td>-137.3 dBW/1 MHz</td>
</tr>
<tr>
<td>6 DVB-T2</td>
<td>1 280.0 MHz</td>
<td>10 MHz</td>
<td>-143.25 dBW/1 MHz</td>
</tr>
</tbody>
</table>

Benefit of moving away from the E6 centre depends on the specific receiver. E.g. (D-star test signal at 0 MHz and 20.46 MHz):
Rx A = 46dB; Rx B = 26dB and Rx C = 13dB improvement.

Rx A has a narrower BW (30MHz) but the difference between B and C (40MHz BW) is not explained.

**Generally the receivers exhibit:**
A higher robustness to NB AS signals when they are transmitted at higher frequency offsets.
A low tolerance to wide-band interference especially when the emission is close to the E6 carrier frequency.
Measurement Campaign - Germany

Four AS Signal type “Groups” used:
G1: signal bandwidth < 1 kHz (Morse, SSB voice);
G2: signal bandwidth up to 15 kHz (FM voice);
G3: signal bandwidth up to 200 kHz (high speed data)
G4: signal bandwidth 1 ... 16 MHz (Amateur TV)

Frequencies chosen according to the IARU band plan and the E6 centre freq.
Germany - Results

- The worst case occurs when an interfering signal is applied on the E6 centre frequency.
- Frequency separation yields significantly higher tolerable levels for the interfering signal.
- ISU can significantly reduce the impact of interfering signals, particularly for narrowband signals.

Wider BW DATV and FM-TV result in lower tolerable levels

Note: ISU = Interference Suppression Unit
Interference Cases

• Two documented national cases of interference
  • One historic case in Germany from ATV to a GALILEO control centre
  • A second in Italy (Varese) from an FM repeater into receivers in the EC JRC in Ispra.
Implications for the 23cm band

• Removing the allocation is **outside the scope** of the WRC related work.
• But there **will be constraints** on large parts of the band for amateur and amateur satellite operation.
• An ITU-R Recommendation is under development (working doc.) in ITU-R WP5A.
  • To provide guidance for administrations on constraints required on amateur service operation to protect the RNSS primary allocation.
• CEPT will mirror this as guidance in a Decision (to harmonise the band for RNSS).
• EU may mandate the guidance in an EC Decision for EU countries.
• At WRC, some countries may try to mandate the guidance in the Radio Regs by incorporation by reference or through an updated WRC Resolution.
Proposals under consideration

• Two elements are considered:
  • Frequency separation.
  • Power level restrictions.

• None of these proposals are agreed at this time but remain under serious consideration:
  • Allow higher power operations (100W) in the range 1298-1300MHz plus…..
  • ….allow higher power (100W) spectrum for ATV (Digital only) at 1250-1254 MHz plus…..
  • …Amateur satellite higher power operation (20W) in 1260-1262 MHz…..
  • …. 5mW power limit across the remaining parts of the 23cm band.
  • Or….only remove ATV operation across the centre of the GALILEO band
  • …identify a small low power segment for FM voice channels around 1293 MHz.
  • Or…..limit all amateur eirp to less than 1W across the entire band.
IARU will continue to:

- Minimise the constraints on the amateur services as far as possible.
- Retain the ability for as many of today’s applications to be able to continue as possible.
  - Narrowband telegraphy and telephony and digital modes
  - Wideband ATV (Digital)
- Work towards minimum disruption to narrow band activities.
  - Maintain cross-region harmonisation of the narrowband section.
- Engagement will continue up to and including the WRC23 itself.