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DRAFT CEPT BRIEF ON AGENDA ITEM 1.2

1.2 to consider in-band power limits for earth stations operating in the mobile-satellite service, meteorological-satellite service and Earth exploration-satellite service in the frequency bands 401-403 MHz and 399.9-400.05 MHz

# ISSUE

Resolution 765 (WRC-15) invites ITU-R to conduct and complete, in time for WRC-19, the necessary technical, operational and regulatory studies on the possibility of establishing in-band power limits for earth stations in the EESS and MetSat in the frequency band 401-403 MHz and the MSS in the frequency band 399.9-400.05 MHz.

It can be noted that this Agenda item may be linked by activities under WRC-19 AI 1.7, since the band 401-403 MHz is identified as a candidate band for a new space operations service (SOS) uplink allocation.

# Preliminary CEPT position

In order to ensure long term continuity for the operation of satellite data collection systems, CEPT supports the establishment of in-band power/e.i.r.p limits, as appropriate, for earth stations in the EESS and MetSat in the frequency band 401-403 MHz and the MSS in the frequency band 399.9-400.05 MHz, taking into account the result of studies. In addition, for the frequency band 401-403 MHz, CEPT is of the view that different sets of limits have to be established for GSO and non-GSO systems.

# Background

This agenda item was created as a result in the significant recent increase in use of the frequency bands 401-403 MHz and 399.9-400.05 MHz for telemetry, tracking and command (TT&C) purposes. This increase is largely attributable to increased interest by educational institutions and especially by private and commercial entities seeking to operate large fleets and constellations of satellites. A large number of these satellite networks are already filed in both bands and as can be seen from filed parameters in the ITU-R database (i.e. large uplink transmit gains for example), plan to use the frequency bands 401-403 MHz and 399.9-400.05 MHz for telecommand (see No. 1.135) (Earth-to-space) purposes under the EESS, MetSat or MSS allocations. The proliferation of such TT&C usage is most likely to have a significant impact upon the large number of existing lower power data collection system (DCS) stations communicating to sensitive receivers on GSO and non-GSO satellites. The output power levels of the earth stations referred to these telecommand links (Earth-to-space) can be much higher than the power levels used for the operation of DCS systems in these frequency bands. In the 401-403 MHz band, an overall of tens thousands of DCS stations communicating with GSO and non-GSO are deployed worldwide for the purpose of collecting essential weather and climate data. In the 399.9-400.05 MHz band, several large constellations under development are planning to operate under the MSS allocation. Work under this item is to determine the potential impact of high power TT&C operations and to determine what, if any, power limitations are appropriate to protect the vital DCS operations in both bands.

399.9-400.05 MHz frequency band

Regarding the frequency band 399.9-400.05 MHz, MSS systems deployed are limited to non-GSO orbits. An example of characteristics of one of these systems (i.e. ARGOS) has at this stage been incorporated in the ITU-R PDNR in terms of capacity and DCP output power. Several large scale systems are in development.

Table 1 below is an excerpt of all satellite network filings at Coordination Request or Notification Status in the ITU SRS 2854 as per 2 October 2017 containing the 399.9 – 400.05 MHz MSS frequency band, all or in part, as allocated for Earth to Space under RR5 and with reference body being Earth. (Not included are satellite network filings made under RR4.4 with operations, for example, in reverse direction).

Table 1: list of MSS frequency band satellite network filings at Coordination Request or Notification Status in the 399.9 – 400.05 MHz MSS frequency band



The total number of non-GSO systems described by the entries in the table and occupying the 399.9 – 400.05MHz band is 13.

The table is ordered by ITU regulatory priority date and includes the maximum combinations of filed power spectral densities and corresponding Earth Station uplink gains for each of these filings. Also shown are the calculated maximum EIRP densities for each of the combinations in dBW/Hz.

Despite the comparatively low number of systems filed in this band, it is apparent from the large Earth Station uplink gains filed that many incumbent systems use this band primarily for TT&C purposes as opposed to genuine MSS operations (like small power/gain Data Collection Services or IoT/M2M) for which this band has been allocated for under RR5.

Several of these incumbent satellite network filings contain emissions with EIRP densities (in dBW/Hz) with some up to 30 dB or more above other satellite networks filings which describe large scale global MSS systems having parameters as ought to be expected for what can be considered as MSS operations in the uplink.

The situation is aggravated by the fact that some existing filings with very large EIRP densities, suggesting TT&C operations, contain only generic Earth Stations in the respective filings as opposed to specific Earth Stations with given geographic locations which, together with the very high-power transmissions used, all but make it impossible to operate genuine MSS anywhere on the globe.

In order to prevent a situation whereas the 399.9-400.05 MHz band becomes all but unusable for large scale/low power MSS uplink operations, the debate surrounding WRC-19 AI 1.2 is trying to address, limit, and over time, find suitable and acceptable means to reign in the use for the 399.9 – 400.05 MHz band for TT&C operations.

401-403 MHz frequency band

The frequency band 401-403 MHz is currently used by many geostationary (GSO) and non-geostationary (non-GSO) Data Collection Platform Systems (DCP). The DCPs gather information activity related to the Earth, the environment and scientific application, weather, environment observation: meteorological and oceanographic, seismic observation, volcanology, geodesy and geodynamics, fishing vessel monitoring, wildlife tracking, homeland security, law enforcement, test/evaluation, monitoring shipments of dangerous goods, humanitarian applications, managing water resources or tsunami warning system, etc. The data which are collected by DCPs are sent and received by satellites in visibility of these platforms, that retransmit the retrieved information to dedicated earth stations.

The DCPs are particularly useful for the collection of data from remote and inhospitable locations where it may provide the only possibility for data relay. DCPs are also deployed in regions with a highly developed infrastructure and the corresponding installations required to relay the data tend to be inexpensive, unobtrusive and normally blend easily into the local environment. DCPs may also transmit their current position, allowing movement to be determined. The DCPs, in particular communicating with non-GSO satellites are usually light and compact, and use little power as possible. DCPs are automatic, or semi-automatic, in-situ environmental observing systems, which may be integrated into an automatic weather station at a remote site; an automatic river or tide gauge, or on an aircraft, ship, balloon or buoy. DCS are provided by several geostationary meteorological satellite operators, giving almost total coverage around the world, except the polar regions. The EUMETSAT contribution to the global DCS network of geostationary meteorological satellites (also including satellites from Russia, China and USA) is provided by the current fleet of Meteosat satellites and will be continued by the Meteosat Third Generation satellites (MTG). The Meteosat satellites located at 0° longitude (Meteosat-10) and over the Indian Ocean (Meteosat-7) at 57.5°E and "brand new" Meteosat-8 at 41.5°E (replacing 57.5°E fully by April 2017), acquire DCP data, in the form of observations and environmental parameters (e.g. temperature, humidity, etc.), from operators of DCPs, which are located within the footprint of the satellites. When the platform is always under the footprint of a single geostationary meteorological satellite it is allocated to a regional transmission channel. If however it is located on a ship or aircraft, which travels across the footprint of several satellites, it is allocated to an International channel.

Regarding the non-geostationary meteorological satellites, the ARGOS receivers are operated on board the current generation of EUMETSAT’s Metop, the NOAA (National Oceanographic Atmospheric Administration) satellites on non-GSO orbits and SARAL (Satellite with ARGOS and ALtiKa). It can be noted that concerning the monitoring of the oceans, the ARGOS system ensures the collection of most ocean observations gathered by buoys or drifters, thereby contributing to the forecasts of the ocean-atmosphere coupled system together with the observations provided by EUMETSAT’s satellites and the Jason altimetry missions. ARGOS is therefore a key tool in predicting climate change and gauging its effects. ICARUS and the Brazilian DCPs also operate within the 401-403 MHz band.

Additionally, incorporating a data collection system on board a moving satellite allows for locating an in-situ platform using Doppler shift calculations. This positioning capability permits applications such as monitoring drifting ocean buoys and studying wildlife migration paths.

Unlike the DCS on GSO meteorological satellites, through ARGOS it is possible to send messages back to the platform in the band 460-470 MHz. This provides the ability for message acknowledgement, time sync of the beacon, update of the beacon activity profile, and updating of the satellite status/position for the beacon.

Deployment of 2 hydrometeorological Arctica-M satellites, located at HEO orbit, is planned after 2018. Those satellites would carry DCS payload to enhance coverage of polar regions and would increase performance of existing regional DCS system, consisting of GSO (Elektro-L satellites) and LEO (Meteor-M) constellations. It is envisaged that the system would operate with existing DCP network, using non-directional antennas, as well as DCP’s with low-directional antennas, similar to GSO DCP’s.

In the framework of the global DCS system through geostationary meteorological satellites, currently Meteosat-10 collects 23000 messages from 1126 DCP stations per day. Meteosat-7 collects 3600 messages per day from 152 DCPs. In addition, according to information published in the framework of the Coordination Group of Meteorological Satellites (CGMS), there are 531 DCPs transmitting their data through Elektro N L1 at 76°E.

In the framework of the non-geostationary DCS system ARGOS, 22000 platforms are in operation worldwide sending more than 3 million messages per day.

The increased spectrum requirements for both geostationary and non-geostationary MetSat and EESS systems require all operators to respect a basic general partitioning of the band 401-403 MHz for current and future DCS systems accompanied by sharing conditions (see figure 1 below derived from Recommendation ITU-R SA.2045 providing the basic general partitioning and sharing conditions for the band 401-403 MHz for future long-term coordinated use of data collection systems on geostationary and non-geostationary MetSat and Earth exploration-satellite service systems). The studies on deriving the proper power limits have to take into account the partitioning and sharing conditions as outlined in this recommendation. It should be noted that there are DCS using spread spectrum technique reducing the interference to other systems. Due to the spreading of the signal, these systems may not fit in the general partitioning.



Figure 1: Basic general partitioning of the band 401-403 MHz for future long-term coordinated use of DCS systems on geostationary and non-geostationary MetSat and EESS systems

According to on-going ITU-R studies, in practice, for non-GSO satellite networks, the values of output power range from –3 dBW (bandwidth of 800 Hz) up to 7 dBW (bandwidth of 6400 Hz). In some applications, the power may decrease down to –25 dBW using specific techniques such as Spread Spectrum Multiple Access. The maximum value of the corresponding antenna gain is below 3 dBi, and in practice the antenna gain does not exceed 0 dBi (to be clarified in the PDNR depending on the type of system). The antennas are most of time omnidirectional and whip antennas are used.

For Meteor-M LEO satellite (not included in the current PDNR), uplink e.i.r.p. would not exceed 12 dBW (bandwidth of 1600 Hz) typically using non-directional antennas with 0-3 dBi gain . For DCP’s, operating with HEO satellites (Arctica-M), uplink e.i.r.p. would not exceed 22 dBW (bandwidth of 400Hz).

Thus, any additional use, other than for DCS, of this limited and unique spectrum resource for DCS systems would have to blend in with appropriate power levels such that the reception of signals from data collection platforms at the satellite receivers is not interfered.

For GSO networks, it can be noted that the International Data Collection System (IDCS) of the DCP is based on the usage of GSO satellites, and the e.i.r.p. at the antenna output shall not exceed 19 dBW under any combination of operational conditions. The transmitted radio frequency shall use the 11 IDCS channels (with centre frequencies spaced 3 kHz apart), from 402.034-402.067 MHz regardless of the GSO spacecraft. Other GSO channels are reserved for DCP, and there are various types of DCP transmitters in operation generally ranging from 5 W, 10 W and 20 W output power with a directional antenna, or 40 W or even higher output power with an omnidirectional antenna. The resulting uplink equivalent isotropically radiated power (e.i.r.p.) is between 6 to 22 dBW.

Given the significant difference in the power level ranges of non-GSO data collection platforms compared to platforms communicating to GSO MetSat and EESS satellites, as outline above, the establishment of power/e.i.r.p. limits will have to differentiate between non-GSO and GSO DCS in the 401-403 MHz frequency band.

To this respect, the establishment of an appropriate set of in-band power/e.i.r.p. limits in the 401 - 403 MHz band will have to take into account the framework set forth by the general partitioning in Recommendation ITU-R SA.2045 (as described in Figure 1 above) to ensure the protection of existing and future use of meteorological operations (MetSat and EESS (Earth-to-space)) in the 401-403 MHz frequency band for both non-GSO and GSO DCS systems.

Considering the high number of satellite networks in the band 401-403 MHz, it was not feasible to provide a similar table as Table 1 for this band. However, the same situation as described for the MSS band 399.9-400.05 MHz applies for the band 401-403 MHz in which a large number of TT&C links are operating with significantly more powerful transmissions compared to DCP. ITU-R WP7B which is responsible for this Agenda item began drafting a Preliminary Draft New Report regarding this agenda item. This report provides detailed technical characteristics of the deployed systems for non-GSO and GSO in the 401-403 MHz frequency range and 399.9-400.05 MHz.

Current status

Taking into account the detailed list of characteristics of GSO and non-GSO satellite networks, as in the ITU-R PDNR, the current status, based on the maximum e.i.r.p., is as follows.

For the frequency band 399.9-400.05 MHz, the maximum e.i.r.p. of the Earth stations shall not exceed 5 dBW for non-GSO networks.

For the frequency band 401-403 MHz, the maximum e.i.r.p. of the Earth stations shall not exceed 22 dBW for GSO/HEO networks, 7 dBW for non-GSO networks.

The PDNR makes reference to the use of a duty cycle, in addition to the above e.i.r.p. limits. This solution needs to be carefully examined.

1. In addition, careful examination should be made whether e.i.r.p. spectral density limits may be used.

In addition, CEPT is studying possible regulatory actions regarding satellite networks operating TT&C links exceeding the agreed limits, in order that over time all satellite systems using either of the bands would be compliant with these limits. Regulatory provisions such as phasing out systems exceeding the limits agreed at WRC19 may be introduced.

# List of relevant documents

ITU-Documentation (Recommendations, Reports, other)

* Recommendation ITU-R SA.2045: Basic general partitioning and sharing conditions for the band 401-403 MHz for future long-term coordinated use of data collection systems on
geostationary and non-geostationary MetSat and Earth exploration-satellite service systems
* Recommendation ITU-R SA.2044: Protection criteria for non-GSO data collection platforms in the band 401-403 MHz
* Recommendation ITU-R SA.1163-2: Interference criteria for service links in data collection systems in the Earth exploration-satellite and meteorological-satellite services
* Recommendation ITU-R SA.1627: Telecommunication requirements and characteristics of EESS and MetSat Service systems for data collection and platform location
* Recommendation ITU-R SA.1162-2: Performance criteria for service links in data collection and platform location systems in the Earth exploration and meteorological-satellite services
* Recommendation ITU-R SA.1164-2: Sharing and coordination criteria for service links in data collection systems in the Earth exploration-satellite and meteorological-satellite services
* Recommendation ITU-R M.2046: Characteristics and protection criteria for non‑geostationary mobile-satellite service systems operating in the band 399.9-400.05 MHz
* Recommendation ITU‑R SA.1159-3: Performance criteria for data dissemination, data collection and direct data readout systems in the Earth exploration-satellite service and meteorological-satellite service
* Annex 16 to Working Party 7B Chairman’s Report, April 2016: working document toward a PDN
Report ITU-R SA.[400 MHz-LIMITS], Sharing studies to consider in-band power limits for earth stations operating in the frequency ranges 399.9-400.05 MHz and 401-403 MHz within the MSS, EESS and MetSat services
* Recommendation ITU-R RA.769: Protection criteria used for radio astronomical measurements

CEPT and/or ECC Documentation (Decisions, Recommendations, Reports)

EU Documentation (Directives, Decisions, Recommendations, other), if applicable

# Actions to be taken

* Establish the range of output power and other relevant characteristics for both GSO and non-GSO systems planned or in operation for the frequency bands 399.9-400.05 and 401-403 MHz
* Study the establishment of the relevant limits for both types of satellite orbits (GSO and non-GSO) and for both frequency bands (the use of the frequency band 399.9-400.05 MHz is limited to non-GSO systems)
* Study possible regulatory actions regarding satellite networks operating TT&C links exceeding the agreed limits.
* To develop a draft ECP

# Relevant information from outside CEPT (examples of these are below)

## European Union (date of proposal)

## Regional telecommunication organisations

APT (July 2017)

APT Members support the ITU-R studies in accordance with Resolution 765 (WRC-15) to conduct and complete, in time for WRC-19, the necessary technical, operational and regulatory studies on the possibility of establishing in-band power limits for earth stations in the EESS and MetSat in the frequency band 401-403 MHz and the MSS in the frequency band 399.9-400.05 MHz, without any constraint to existing services (including DCS and non-DCS systems).

ATU (September 2017)

The APM19-2 agreed to:

Support the studies for the in-band power limits for earth stations operating in the mobile-satellite service, meteorological-satellite service and Earth exploration-satellite service in the frequency bands 401-403 MHz and 399.9-400.05 MHz to ensure protection of existing and future meteorological operations. In this regard, APM19-2 is invited to urge African administrations to contribute and actively participate in the studies.

Arab Group (20 April 2017)

* Follow up the ongoing studies in the ITU-R.
* Supporting the ongoing studies in order to establish in-band power limits for earth stations operating in Mobile satellite service (MSS), Meteorological satellite service (MetSat) and Earth exploration service in the frequency bands 401-403MHz and 399.9-400.05MHz, in order to ensure the protection of the existing services without imposing any additional constraints in these services due to the massive usage of the fixed and mobile services in these frequency bands in the countries.

CITEL (June 2017)

CAN, USA

To support conducting and completing the necessary technical, operational, and regulatory studies on the possibility of establishing in-band power limits for earth stations in the EESS and MetSat service in the frequency band 401-403 MHz and the MSS in the frequency band 399.9-400.05 MHz.

RCC (April 2017)

The RCC Administrations consider that studies should be conducted to establish power limits for earth stations used for space operation functions in the frequency bands 401-403 MHz and 399.9−400.05 MHz in order to avoid interference to data collection systems in the meteorological-satellite service, Earth exploration-satellite service and mobile-satellite service.

## International organisations

IATA (date of proposal)

ICAO (date of proposal)

IMO (date of proposal)

NATO (27 June 2017)

This NATO military assessment summary is a common military assessment of the NATO Nations on the potential impacts and benefits of Agenda Item 1.2. It does not constitute a common position of the NATO Nations.

The frequency bands 401-403 MHz and 399.9-400.5 MHz are in use to support NATO military operations in the various allocated services by dedicated military and non-military applications, such as Data Collection System (DCS). Currently undefined power limits in these frequency bands represent a potential threat to in-band systems used in support of NATO military operations.

SFCG (September 2017)

SFCG supports studies and analyses under Agenda Item 1.2 to establish appropriate in-band power limits for earth stations operating in mobile-satellite service (399.9-400.05 MHz), the meteorological satellite service (401-403 MHz) and the Earth exploration-satellite service (401-403 MHz), in order to preserve, on a long term basis, the operation of Data Collection Platforms. For this purpose, a set of in-band power/e.i.r.p. limits will have to be tailored to ensure the operations of both NGSO and GSO systems.

This agenda item may be impacted by activities under WRC-19 AI 1.7, since the band 401-403 MHz is identified as a candidate band for a new space operations service (SOS) uplink allocation. Negative impacts on the DCS activities in 401-403 MHz should be avoided. Therefore, any potential new allocation to SOS added to this band under Agenda Item 1.7 would have to be consistent with those limits established under Agenda Item 1.2.

WMO and EUMETNET (January 2017)

WMO supports the establishment of an appropriate set of in-band power/e.i.r.p limits to ensure protection of existing and future use of meteorological operations (e.g. METSAT and EESS (Earth-to-space)) in the 401-403 MHz frequency band for both non-GSO and GSO DCS systems.

## Regional organisations

ESA

Same as SFCG

Eurocontrol (date of proposal)

EUMETSAT (February 2017)

EUMETSAT supports the establishment of an appropriate set of in-band power/e.i.r.p. limits, differentiating between non-GSO and GSO DCS systems, to ensure the protection of existing and future use of meteorological operations (MetSat and EESS (Earth-to-space)) in the 401-403 MHz frequency band.

In addition, EUMETSAT stresses that the frequency bands 401 - 403 MHz and 399.9 - 400.05 MHz are unique spectrum resources for the operation of data collection systems (DCS) through GSO and non-GSO meteorological satellites. EUMETSAT embarks receivers on their currently operational Meteosat and Metop satellites and their next generation satellites (already under development), namely Meteosat Third Generation (MTG) and Metop Second Generation (Metop-SG), in order to provide continuity in the measurement data gathered by the variety of data collection platforms. Thus, it is of paramount importance to preserve the usability of these frequency bands 401 - 403 MHz and 399.9 - 400.05 MHz for DCS systems in the long term.

## OTHER INTERNATIONAL AND REGIONAL organisations

EBU (date of proposal)

GSMA (date of proposal)

CRAF (November 2016)

CRAF supports the studies towards the establishment of in-band power limits for earth stations in the EESS and MetSat in the frequency band 401-403 MHz and the MSS in the frequency band 399.9-400.05 MHz. The RAS stations operating at 406.1-410 MHz may benefit from the presumably reduced power limits of such earth stations.