ESA response to the Consultation in the context of the development of an RSPG Opinion on priorities and objectives for the Community in the World Radiocommunication Conference 2007

Executive Summary

This contribution by the European Space Agency answers to the questions asked in the frame of the RSPG consultation process: Priorities and objectives for the European Community at WRC-07.
The answer focuses on one specific agenda item (1.20: unwanted emissions). ESA sees the proper handling of this agenda item at WRC-07 as a key element to guarantee that the data derived from satellite microwave measurements will be available also in the medium-, long-term for meteorology and other key applications covered by the EC-ESA initiative GMES (Global Monitoring for Environment and Security).
The resolution of this agenda item could also generate, as by-product, a general improvement in the efficiency of the spectrum usage and a stimulus to the European industry to develop the associated technology.
An annex is also included to give additional information on the use of those EESS (passive) bands covered under agenda item 1.20. The annex clarifies the operational nature of the use of these frequency bands.

Answers to issues submitted for consultation

1) What are the agenda items at WRC-07 (to be specified by the respondent) which potentially could have a significant positive or negative impact on common European policies and on important pan-European industrial sectors?

Although ESA has interest in multiple radiocommunication services, the main interest with respect to the work related to WRC-07 resides in the field of Earth observation. Therefore, our comments will concentrate on those WRC-07 agenda items pertaining directly to the Earth exploration-satellite service (EESS). In this area, Agenda Item 1.20 is seen as the most important and challenging agenda item for ESA at WRC-07. The text for agenda item 1.20 is as follows:
"to consider the results of studies, and proposals for regulatory measures, if appropriate, regarding the protection of the Earth exploration-satellite service (passive) from unwanted emissions of active services in accordance with Resolution 738 (WRC 03)"

In the absence of proper regulatory protection of the bands covered by Agenda Item 1.20, the risk is that fundamental frequency bands for meteorology and environmental measurements will be polluted beyond any possible recovery strategy. The economical, strategic and social importance of these applications for European governments and individual citizens is obvious.
In addition, the creation of clear worldwide regulations will guarantee that no operator of active radio services will be penalised for taking a responsible approach towards the problem of spectrum sharing efficiency.

Other agenda items related to Earth observation (such as 1.2, 1.3, 1.8, 1.17) are thought to be of less complexity due to the more classical nature of these agenda items, which focus on individual allocations or sharing studies in specific bands. Notwithstanding the fact that these agenda items are also of big importance to Earth observation, they will not be discussed in this document.

2) Which are the broad objectives which Europe could set itself for these agenda items, bearing in mind that many technical constraints are not yet clarified, and the fact that non-European interests might not support such objectives during the negotiations?

Europe's objective for agenda item 1.20 should be to support and propose appropriate regulatory measures to ensure the protection of the Earth exploration satellite service (passive) from unwanted emissions, without placing an undue burden on the relevant active services.

3) Is it currently foreseeable that there could be contrasting requirements for different Community policies which would need to be interpreted preferably before the WRC-07 negotiations? If so, where?

The active services pertaining to agenda item 1.20 are the fixed, mobile, fixed satellite, inter-satellite, space operation and radiolocation services. Since under this agenda item solutions for unwanted emissions from adjacent or nearby bands into exclusively passive service bands are requested, for already existing allocations, taking into account the answer under *2)* no contrasting requirements can be foreseen.

Regulations on unwanted emissions are on the long-term benificial for both active and passive systems. Better use of the spectrum will be facilitated with such regulations. Consequently, commercial, governmental and military users will directly benefit from clear regulations on unwanted emissions. As ESA is also heavily involved in active radio systems, we understand the technical implications of such regulations and are of the opinion that current technology already enables suitable unwanted emissions reduction. It is clearly understood that any regulation would not be applicable to systems already deployed, but only for those systems deployed after a certain date in the future, so as to enable a smooth transition of systems to the new regulatory environment on unwanted emissions.

As explained in the annex to this document, the main use of the EESS (passive) frequency bands under this agenda item is in the field of operational meteorology. National meteorological offices and international weather centres are increasingly relying on satellite data. The relevant community policies where this use of the EESS (passive) is apparent are Space, Environment, Research and Development.

Also it is interesting to note that GMES (**G**lobal **M**onitoring for **E**nvironment and **S**ecurity), as a joint initiative of the European Commission and the European Space Agency, spans both technical and policy domains. GMES is the European contribution to the Global Earth Observations (GEO) and warning system which development was triggered as an immediate consequence of the Earth Observation Summit held in Washington in 2003. EU policies, together with other policies at national level or policies being driven by an international agenda (for example, international environmental conventions), will be the driver for the services to be delivered under GMES. Both active and passive remote sensing is currently foreseen in the space segment of GMES.

4) How to effectively promote at the conference and within ITU the Common Proposals on spectrum selected by Europe in other regions of the world, in order to enable European industry and consumers to benefit from lower barriers to trade and greater economies of scale?

The promotion of European positions prior to the Conference is already practised by CEPT in a good manner. It is difficult to assess the second part of this question in the light of agenda item 1.20.

5) How to ensure that generic regulatory principles enshrined in Community legislation for various spectrum-using sectors are supported in the WRC-07 process, and notably the principles of technology neutrality, fair competition, regulatory transparency, non-discrimination and proportionality, as well as the optimisation of spectrum use?

In this case any regulatory measures that will result from this agenda item will be based on numerical limits on unwanted emissions. The way to respect these limits will be by definition technology-neutral. It would be important that these regulations would have a worldwide applicability so as to avoid different regional regulations that could lead to unfair competition between different operators or manufacturers.

6) What should be the strategy approaches before and during the conference for European delegations to optimise the possibility to reach the above-identified common European objectives? Should some European Common Proposals be mandatory for EU members?

The European process prior to a World Radiocommunication Conference is such that within Europe compromises are being made between the different interested parties. Ideally, this would mean that the European process would already bring the resulting ECP close to the possible outcome of the conference itself.
But a more intensive coordination among the regional organisations (again prior to a WRC) could help the mutual understanding of their respective positions whereby especially the rationale that led to the formulation of the ECPs would need to be clearly explained.
ECPs should not be made mandatory, but if some EU Member States do not want to commit to specific ECPs, they should not be able to speak against ECPs during the World Radiocommunication Conference. In theory, this is already practised within CEPT.

7) Are the current procedural arrangements for the European WRC preparations, such as participation to and scheduling of meetings, drafting of European Common Positions and Briefs, availability of information, etc., appropriate? If not, please suggest ways to improve this process.

Yes.

8) If applicable, please indicate your early views on issues Europe could propose to be included in the agenda for the next conference after WRC-07 (see the preliminary agenda proposed by WRC-03 in **annex 3**).

Depending on the outcome of ITU-R Task Group 1/8 on Ultra-Wide Band issues, Europe may want to promote future agenda items that would put clear regulatory boundaries to the use of UWB equipment, not leaving their regulations to purely national or regional decisions. Particular concern is associated with the protection of the Galileo bands and of the purely passive bands where no emissions are to be allowed (footnote 5.340 from the Radio Regulations).

As for agenda item 2.2 (Allocations between 275 and 3000 GHz), ESA is of the opinion that, while the requirements from the passive services already operating in that range are relatively well-known, this is not at all the case for active services. Therefore, the objective of the agenda item should simply be to raise the regulatory status of the bands listed in footnote 5.565, after revision of its content.

ANNEX

Use of those Earth exploration satellite (passive) service frequency bands pertaining to Agenda Item 1.20 (WRC-07)

Passive sensing involves the use of pure receivers, with no transmitters involved. The radiation sought by these receivers occurs naturally and is extremely weak. All matter is continually radiating electromagnetic waves and as each molecule in the atmosphere or each surface property has a unique frequency signature, it can thus be recognised. Of interest are radiation peaks indicating the presence of specific chemicals, or the absence of certain frequencies indicating for example the absorption of the frequency signals by atmospheric gases. The strength or absence of signals at particular frequencies is used to determine whether specific gases (moisture and pollutants being obvious examples) are present and if so, in what quantity and at what location. A variety of environmental information can be sensed in this manner. Signal strength on a given frequency may depend on several variables, making the use of several frequencies at the same time necessary to match the multiple unknowns. The use of multiple frequencies is the primary technique used to measure various characteristics of the Earth surface.

Passive microwave radiometry is a tool of fundamental importance for the EESS. The EESS operates passive sensors that are designed to receive and measure natural emissions produced by the Earth surface and its atmosphere. Within ITU-R, this radiocommunication service is denoted as the Earth exploration satellite (passive) service. The frequency and the strength of these natural emissions characterize the type and the status of a number of important geophysical atmospheric and surface parameters (land, sea, and ice caps), which describe the status of the Earth/atmosphere/oceans system, and its mechanisms:

- Earth surface parameters such as soil moisture, sea surface temperature, ocean wind stress, ice extension and age, snow cover, rainfall over land, etc;
- Three-dimensional atmospheric parameters such as temperature profiles, humidity profiles, total water vapour content and concentration profiles of radiatively and chemically important trace gases (for instance ozone and chlorine monoxide).

Microwave techniques render possible observation of the earth's surface and its atmosphere from space orbit even in the presence of clouds, which are almost transparent at frequencies below 100 GHz. This "all-weather" capability has considerable interest for the EESS because more than 60% of the earth's surface is overcast with clouds. Passive microwave sensing is an important tool widely used for meteorological, climatological, and environmental monitoring and survey (operational and scientific applications), for which reliable repetitive global coverage is essential.

Passive sensors integrate the radiation emitted by all natural (wanted) and man-made (unwanted) sources. They cannot, in general, differentiate between these two kinds of signals because the atmosphere is a highly unstable medium with fast changing characteristics, spatially and temporally. They are therefore extremely vulnerable to interference, which may have very serious detrimental consequences:

- It was demonstrated that as few as 0.1 % of contaminated satellite data could be sufficient to generate unacceptable errors in Numerical Weather Prediction forecasts, thus destroying confidence in these unique all weather passive measurements;
- The systematic deletion of data where interference is likely to occur may render impossible the recognition of new developing weather systems, and vital indications of rapidly developing potentially dangerous storms may be missed;
- For climatological studies and particularly for "global change" monitoring, interference may lead to misinterpretation of climate signals.

Within WRC-07 Agenda Item 1.20 covered by Resolution 738, a total of five EESS (passive) bands need to be addressed, i..e.

- 1400 – 1427 MHz
- 23.6 – 24.0 GHz
- 31.3 – 31.5 GHz
- 50.2 – 50.4 GHz
- 52.6 – 54.25 GHz

This annex will highlight the particular use of these bands by the EESS (passive), e.g. their use in operational meteorology, climatology and numerical weather prediction (NWP).

From these 5 bands, the last 4 are currently being used in operational meteorology. Information from measurements in these bands is not only used for weather forecasts, but also for climate research. Especially for this application, continuity of these measurements over a long period (i.e. many decades) is crucial to the understanding of the climate, its related changes and its variability on all timescales.
National meteorological offices and international weather centres are increasingly relying on satellite data. Given the decrease of traditional measuring networks, satellite remote sensing is a crucial method of achieving global coverage with sufficient coverage in time also.

1400 – 1427 MHz

Applications arising from use of this passive band can be classified as 'pre-operational' as its overall value for soil moisture and ocean salinity retrievals is still being assessed. NASA/JPL is currently developing an instrument for measuring soil moisture (the HYDROS mission), which will collect measurements in the entire passive microwave band under consideration (1400 to 1427 MHz). The European Space Agency (ESA) is developing a separate instrument (the SMOS mission), using a different technological approach, for measurements of soil moisture and ocean salinity. HYDROS and SMOS are complementary missions, both requiring high-precision radiometric measurements globally and continuously in time. Frequencies near 1400 MHz are ideal for measuring soil moisture, and also for measuring sea surface salinity and vegetation biomass. Soil moisture is a key variable in the hydrologic cycle with significant influence on evaporation, infiltration and runoff. In the vadose zone (i.e. the region between the land surface and underlying groundwater aquifers/ducts), soil moisture governs the rate of water uptake by vegetation. Sea surface salinity has an influence on deep thermohaline circulation[1] and the

[1] The thermohaline circulation is a global ocean circulation. It is driven by differences in the density of the sea water which is controlled by temperature (thermal) and salinity (haline). In the North Atlantic it transports warm and salty water to the North. There the water is cooled and sinks into the deep ocean. This newly formed deep water is subsequently exported southward. This slow (~0.1 m/s), but giant circulation has a flow equal to about 100 Amazon Rivers. Together with the Gulfstream it contributes (2/3 and 1/3) to the comparatively warm sea surface temperature along the coast of western Europe and to the relative mild European winters. Once the water are in the deep, they remain from the atmosphere for up to 1000 years.

meridional heat transport. Variations in salinity influence the near surface dynamics of tropical oceans. To date, there is no capability to measure soil moisture and sea surface salinity directly on a global basis, so the protection of this passive band is essential as this band seems to qualify most for enabling such observations.

23.6 – 24.0 GHz

Out of the 447 MHz bandwidth allocated for purely passive applications in the first 30 GHz of the spectrum, the 400 MHz in the band 23.6-24 GHz represents by far the largest share. This in itself indicates the importance of this band for the passive services. This band covers the flank of the water vapour spectral line (located at 22.235 GHz).
The measurements made at 24 GHz directly lead to the total column water vapour content in the atmosphere. This is crucial for weather forecasting at local and global level. The potential loss of these data that are assimilated in Numerical Weather Prediction (NWP) models will severely affect the quality of weather forecasting.
Also, this band is used for correcting temperature measurements (made between 50-60 GHz) for attenuation due to water vapour. Without correct measurements at 24 GHz, temperature measurements at 50-60 GHz cannot be corrected for attenuation due to water vapour content in the atmosphere and thus have severely increased errors that feed back in the NWP models and potentially result in wrong interpretation and in degraded weather forecasts.

31.3 – 31.5 GHz

Above 26 GHz the opacity of the atmosphere due to water vapour declines to a minimum close to 30 GHz, before slowly rising again. Sensitivity to cloud liquid water continues to rise such that at 30 GHz sensitivity to cloud is greater than sensitivity to water vapour. The water vapour absorption is largely due to the water vapour continuum.
This channel is therefore used as a window channel to correct at other frequencies for cloud liquid water as well as surface contributions. It is also used for carrying out polarimetric sea surface observations to derive wind speed and direction. In particular these wind observation are extremely vulnerable to contamination due to their very low signal intensity.

50.2 – 50.4 GHz & 52.6 – 54.25 GHz

These channels are used for temperature profile observation using the O_2 absorption spectrum in the vicinity of 60 GHz.
The main purpose of using channels in this frequency range is to provide temperature sounding information. The provision of channels in this frequency regime has a proven very large positive impact on NWP equating to 1-2 days in forecast period (a 2 day benefit means that the 3 day forecast with the observations is as accurate as the one day forecast without the data).

The volume-mixing ratio of oxygen in the atmosphere up to approximately 90 km stays constant while the atmosphere pressure becomes larger towards the Earth surface according to a known exponential law. By making use of these two effects, the atmospheric temperature can be calculated. Channels further away from the oxygen absorption spectrum (e.g. 52.6 – 54.25 GHz are sensitive to lower altitudes than those channels closer to 60 GHz).
By measuring at several channels within the flank of the O_2 absorption spectrum and correcting for several factors (for which information is obtainable in the 31 GHz and 24 GHz frequency bands), an accurate temperature profile of the atmosphere results.