



Report ITU-R SA.2164
(09/2009)

Compatibility between the meteorological satellite and the fixed services in the band 7 850-7 900 MHz

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***Note:** This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.*

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1 Introduction

World Radiocommunication Conference 2012 (WRC-12) Agenda item 1.24 considers the extension of the existing primary allocation to the meteorological-satellite service in the band 7 750-7 850 MHz to the band 7 850-7 900 MHz. Applications in the meteorological satellite service are limited to non-geostationary satellites transmitting in the space-to-Earth direction. Although the same service applications are affected as in the current allocation 7 750-7 850 MHz, and noting that meteorological systems already share this band successfully with the fixed service, this assessment covers all potential modes of operation and compatibility aspects for the potential extension to 7 850-7 900 MHz.

2 Background

Several polar orbiting meteorological satellite systems are currently using or planning to use the band 7 750-7 850 MHz. The main mode of operation is data transmission to a dedicated earth station in high latitudes, such as Svalbard on Spitsbergen, Norway. One of the systems operates in a multi-user mode transmitting meteorological data to a number of user stations, operated mainly by national weather services. Table 1 shows typical data of the 3 representative systems EUMETSAT polar-orbiting meteorological satellite system (Metop), United States National Polar-orbiting Operational Environmental Satellite System (NPOESS) and the second generation of polar-orbital meteorological satellites of China (FY-3).

The measurements and observations performed by those MetSat systems, provide data used in the areas of operational meteorology, climate monitoring, and detection of global climatic changes, having significantly improved operational meteorology, in particular the Numerical Weather Prediction (NWP).

Determined by the users of those data, namely the National Weather Services, next generation of these non-geostationary MetSat systems will have to provide continuity to the measurements and observations performed by the current systems. Furthermore, these future systems will have to perform additional measurements and observations of meteorological and climate parameters with higher resolution, resulting in much higher data rates and bandwidth as required today.

The necessary bandwidth for the downlink of the raw instrument data for future non-geostationary MetSat systems that fulfil those requirements for further enhanced data in the area of operational meteorology and climatology would be up to 150 MHz.

TABLE 1
**Characteristics of some meteorological satellite system
 applications in the band 7 750-7 850 MHz**

	Metop	NPP	NPOESS	FY-3
Carrier frequency (MHz)	7800	7812	7834	7775
Orbit height (km)	817	824	828	836
Maximum bandwidth (MHz)	63.0	30	30.8	45.0
Modulation scheme	QPSK	QPSK	SQPSK	QPSK
Satellite EIRP (dBW)	13.5	12.9	20.4	19.6
Earth station antenna diameter (m)	10.0	3.0	2.0	3.0
Earth station antenna gain (dBi)	55.2	44.9	41.7	45.2
Maximum PFD on surface of earth (dB(W/m ² · 4 kHz))	-165.9	-162.9	-155.6	-158.1
Margin with respect to PFD limit (dB)	13.9	10.9	3.6	6.1

The desired extension of the MetSat allocation into the band 7 850-7 900 MHz would only affect the same radiocommunication services, namely the FIXED and MOBILE (except aeronautical mobile) service, like in the band 7 750-7 850 MHz where the METSAT service is already allocated on a co-primary basis limited to NGSO applications. Compatibility was already demonstrated in preparation for (WRC-97) where the allocation to the MetSat in the band 7 750-7 850 MHz was originally added to the table of allocations in Article 5 of the Radio Regulations (RR). Studies conducted prior to (WRC-97) concluded that more than 13 dB of margin were available to protect fixed service systems operating with worst case azimuths along the sub-satellite track. In particular the interference impact on the fixed and mobile service from the downlink of a polar-orbiting MetSat system like Post-EPS to its dedicated earth station is very limited as such an earth station is deployed at high northern (Svalbard, Spitsbergen) or southern latitudes (McMurdo, Troll, O'Higgins, Antarctica) in order to avoid blind orbits in which the stored instrument data of an entire orbit cannot be received.

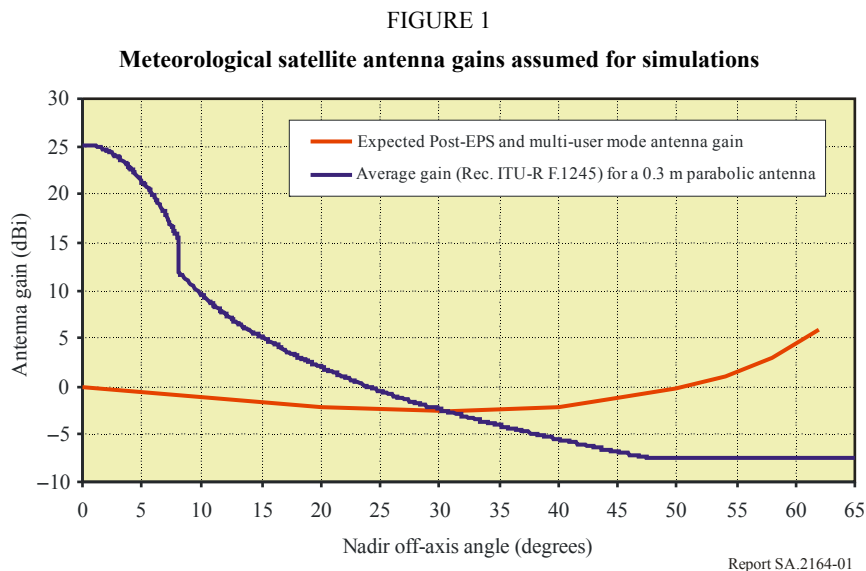
For other applications such as the dissemination of data directly to the user (so-called direct read-out), for which the number of reception stations could be higher and which could be located anywhere, the sharing situation needs to be studied. Currently there are two systems (NPP and NPOESS of NOAA) planned for such type of operations which requires around 30 MHz of contiguous spectrum. For another system (Fengyun-3 or FY-3 from China), the dissemination of data is planned to be restricted mainly to the territory of China. The first satellite FY-3A was launched in 2008. The objective of this assessment is to provide a comprehensive overview of the impact all potential future meteorological system applications may have on fixed service installations.

3 Meteorological satellite system description

The next generation meteorological satellite system design such as Post-EPS will focus on wideband data dump transmissions into few main earth stations at high latitudes, such as Svalbard, Kiruna, Fairbanks, Troll, McMurdo and O'Higgins. The systems are expected to have bandwidth requirements up to 150 MHz. These high bandwidth requirements are primarily due to transmission of data from high resolution sensors and other instruments.

All currently operated and planned systems are deployed in non-geostationary orbits with typical orbital heights between 800 and 850 km and an inclination of around 98° and the same will apply for future systems. Earth stations in very high northern and southern latitudes are preferred in order to maximize contact time between the satellites and the earth stations. Transmissions are typically only affected when in line of sight of the corresponding earth station at elevation angles in excess of 5°. To date, two systems are planned to operate in a multi user mode with the transmitter continuously active. Power flux densities of systems using this frequency band for stored instrument data dump transmissions are typically significantly below the PFD limits but for the compatibility assessments, the satellites will be assumed to operate at the PFD limit. Antenna types are currently cardioid but for the higher data rates parabolic antennas may be needed. The most likely modulation technique for such high data rates is 8-PSK.

Figure 1 shows the assumed antenna gains for cardioid antennas based on currently implemented antennas as well as parabolic antennas likely to be used for future systems.



Earth station receiving antenna diameters can in principle vary between 2 m for low data rate direct read-out reception in multi-user modes and 13 m for stored instrument data dump reception earth stations. Table 2 shows link budget examples for future meteorological satellite systems covering all potential operating modes and antenna types. For the stored instrument data dump reception station, the currently used antenna in Svalbard with a diameter of 10 m was selected.

TABLE 2
**Link budget examples for future meteorological satellite systems
operating around 7.8 GHz**

	System A	System B	System C
Carrier frequency (MHz)	7 825	7 825	7 825
Orbit height (km)	830	830	830
Maximum bandwidth (MHz)	150	150	150
Minimum elevation angle (degrees)	5	5	5
Modulation scheme	8-PSK	QPSK	8-PSK
Satellite RF power in dBW (dBW)	23.0	24.8	3.8
Satellite antenna type	cardioid	cardioid	parabolic
Maximum satellite antenna gain (dBi)	6.0	6.0	25.2
Satellite EIRP (dBW)	29.0	30.8	29.0
Distance satellite – Earth station for 5° (km)	2 848	2 848	2 848
Free space propagation loss (dB)	179.4	179.4	179.4
Rain margin for 99.9% availability (dB)	2.2	2.2	2.2
Short term downlink loss (dB)	181.6	181.6	181.6
Earth station antenna diameter (m)	10.0	2.2	4.0
Earth station antenna gain (dBi)	55.3	42.1	47.3
Short term signal power level at receiver input (dBW)	−97.4	−108.7	−105.3
Receiver system temperature (K)	180	180	180
Maximum PFD on surface of earth (dB(W/m ² · 4 kHz))	−152.0	−152.0	−152.0
Margin with respect to PFD limit (dB)	0.0	0.0	0.0
Receiver noise power density (dBW/Hz)	−206.0	−206.0	−206.0
Signal to noise density ratio (C/N_0) – Short-term (dB/Hz)	108.7	97.3	100.8
Required E_b/N_0 (with coding gain if applicable) (dB)	13.0	7.5	13.0
System margin – Short-term (dB)	9.2	5.1	1.2

4 Fixed service system assumptions

Recommendation ITU-R F.758 contains relevant information on fixed service characteristics in the band 7 850-7 900 MHz. Annex 1 of that Recommendation provides information on basic considerations in the development of sharing criteria, and Tables 12 and 13 of Annex 2 provide characteristics of typical FS systems in this band. Table 44 of Recommendation ITU-R F.758 specifies minimum antenna gains. Table 3 contains the relevant system characteristics extracted from Annex 2 of Recommendation ITU-R F.758. The methods for analysing interference between non-geostationary satellites and the FS are described in Recommendation ITU-R F.1108. This Recommendation makes also reference to related Recommendations ITU-R F.1094, ITU-R F.1668 and ITU-R F.1703, which have been taken into account.

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