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Recommendation ITU-R SA.1019-1

(07/2017)

Frequency bands and transmission directions for data relay satellite networks/systems

SA Series

Space applications and meteorology

International Telecommunication Union

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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R SA.1019-1

Frequency bands and transmission directions for data relay satellite networks/systems

(Question ITU-R 118/7)

(1994-2017)

Scope

This Recommendation provides the recommended frequency bands and the transmission directions for data relay satellite networks/systems.

Keywords

DRS, space-to-Earth, Earth-to-space, space-to-space, forward feeder link, return feeder link

Related ITU-R Recommendations and Reports

Recommendations ITU-R SA.510, ITU-R SA.1018, ITU-R SA.1155, ITU-R SA.1274, ITU-R SA.1275, ITU-R SA.1276, ITU-R SA.1414.

The ITU Radiocommunication Assembly,

considering

a) that data relay satellite networks/systems are in operation or are planned corresponding to the Hypothetical Reference System for Data Relay Satellite (DRS) Systems of Recommendation ITU-R SA.1018;

b) that these DRS systems support links with widely different characteristics as described in the Annex;

c) that some DRS user spacecraft require links of low data rate (up to about 6 Mbit/s) which require modest bandwidths which can be most economically implemented, using low-power transmitters, simple wide-beam antennas without complex pointing mechanisms and robust receivers, in frequency bands for DRS inter-orbit links below 3 GHz;

d) that some DRS user spacecraft require links from wide-beam or omnidirectional antennas (in particular to support contingency links) in cases where the attitude of the user spacecraft and the direction of the DRS is not accurately known, thus requiring the use of frequency bands for DRS inter-orbit links below 3 GHz;

e) that some DRS user spacecraft require links of medium to high data rates (from about 6 Mbit/s up to more than 600 Mbit/s) thus requiring the use of frequency bands for DRS inter-orbit links above 10 GHz;

f) that the frequency bands available and suitable for DRS inter-orbit links are limited;

g) that the forward and return feeder links of data relay satellites could use bands allocated to the fixed-satellite service;

h) that the normal-mode operations of data relay satellites should use their own forward and return feeder link frequency bands;

i) that launch, early-orbit-phase and emergency operations of data relay satellites require the use of wide-beam or omnidirectional antennas, which require the use of frequency bands below 3 GHz;

j) that the choice of common frequency bands for different data relay satellite systems permits the consideration of interoperability between user spacecraft designed to use one DRS system and data relay satellites of another DRS system;

k) that Recommendation ITU-R SA.1414 provides parameters including frequencies for DRS systems worldwide to be used as guidance for deriving sharing criteria and coordination thresholds,

recommends

1 that the inter-orbit links for DRS user spacecraft requiring low data rates using wide-beam or omnidirectional antennas use assignments within the allocated bands:

1.1 2 025-2 110 MHz band for the forward inter-orbit link;

1.2 2 200-2 290 MHz band for the return inter-orbit link;

2 that the inter-orbit links for DRS user spacecraft requiring medium data rates consider assignments within the allocated bands, subject to the limitations of a secondary allocation:

2.1 13.4-14.3 GHz band for the forward inter-orbit link;

2.2 14.5-15.35 GHz band for the return inter-orbit link;

3 that the inter-orbit links for DRS user spacecraft requiring medium to high data rates use assignments within the allocated bands:

3.1 22.55-23.55 GHz band for the forward inter-orbit link;

3.2 25.25-27.50 GHz band for the return inter-orbit link;

4 that the launch, early-orbit-phase and emergency operations of a DRS use the 2 025-2 110 MHz and 2 200-2 290 MHz bands;

5 that the frequency bands shown in Table 1 below should be used for DRS system reference architecture links taking into account the information available in Recommendation ITU-R SA.1414.

TABLE 1

DRS System frequency bands and directions of transmission

Application	**Direction of transmission**	**Frequency**
Inter-orbit link Low data rate (<6 Mb/s) requirement Wide-beam or omnidirectional antennas of the DRS users	Forward	2 025-2 110 MHz
	Return	2 200-2 290 MHz
Inter-orbit link Medium data rate(6-300 Mb/s) requirement	Forward	13.4-13.75 GHz 13.75-14.3 GHz
	Return	14.5-15.35 GHz

TABLE 1 (*end*)

Application		Direction of transmission	Frequency
Inter-orbit link High data rate (>300 Mb/s) requirement		Forward	22.55-23.55 GHz
		Return	25.25-27.5 GHz
DRS satellite feeder links Launch, early orbit, and contingency command and telemetry		Uplink	2 025-2 110 MHz
		Downlink	2 200-2 290 MHz
DRS satellite feeder links	Low and medium data rate requirement	Forward feeder link (Uplink)	14.5-15.35 GHz
			12.75-13.25 GHz 14.5-14.75 GHz
	High data rate requirement		27.5-31 GHz
	Low and medium data rate requirement	Return feeder link (Downlink)	13.4-13.75 GHz 13.75-14.3 GHz
			10.7-11.7 GHz 12.5-12.75 GHz 13.4-13.65 GHz
	High data rate requirement		17.7-21.2 GHz
			25.5-27 GHz (see Note 1)

NOTE 1 – In the frequency band 25.5-27 GHz, the return DRS-to-Earth feeder link carries only signals in the space research and Earth exploration-satellite services.

Annex

1 Introduction

Communication between the ground and low-Earth orbiting spacecraft and launch vehicles used for space research, Earth exploration and other purposes is essential. Such communications may be required to be continuous or near-continuous, or may be required while the spacecraft are passing over specific points on the Earth's surface. Land based earth stations have only a limited visibility and existing stations are only capable of covering a portion of any low-Earth orbit. Moreover, it is not economically or practically feasible to extend networks of land-based stations to provide full or more complete coverage of the low-Earth orbits. In contrast, a data relay satellite (DRS) system including one or more DRS satellites in geostationary orbit has substantially larger visibility of the low-Earth orbits used by these satellites than existing land-based earth stations, and can therefore provide significantly enhanced coverage.

A single DRS satellite in geostationary orbit can provide communications between an earth station and a low-orbiting spacecraft for more than one-half of its orbit. Two such DRSs, suitably located in geostationary orbit, with a wide separation angle, can provide communications between two co-located earth stations and a low-orbiting spacecraft almost continuously, with the exception only of a zone of exclusion (ZOE), above the part of the Earth opposite to these earth stations. Moreover; two such DRSs, suitably placed in geostationary orbit, can provide fully-continuous coverage between two separate earth stations and a low-orbiting spacecraft. A DRS system can also serve additional earth stations, either both transmitting and receiving or only receiving signals from user spacecraft.

2 Description of the data relay satellite network/system

A DRS consists of one or more DRS spacecraft in geostationary orbit and one or more DRS earth stations. The system relays information between the earth station(s) and DRS users, which can include low-Earth orbiting spacecraft, launch vehicles, and even ground based or aeronautical platforms. A DRS system must be capable of supporting at least four distinct links:

– an Earth-to-space link in the forward direction, from the earth station to the data relay satellite (known as the uplink or the forward feeder link);
– a space-to-space link in the forward direction, from the data relay satellite to the low orbit spacecraft (known as the forward inter-orbit link);
– a space-to-space link in the return direction, from the low orbit spacecraft to the data relay satellite (known as the return inter-orbit link); and
– a space-to-Earth link in the return direction, from the data relay satellite to the earth station (known as the downlink or the return feeder link).

In the forward direction, the input to the DRS system reference architecture corresponds to the baseband data provided at the input of the DRS earth station modulator which modulates the feeder uplink carrier.

This baseband data typically consists of command data and (in the case of manned missions) voice and video information. It is provided to the DRS earth station over an external interface (landline communication, RF terrestrial link, etc.) by the Mission Operations Control Center (MOCC) responsible for the user spacecraft. Note that the MOCC and the external interface to the DRS earth station are not part of the reference architecture.

For the case of a demodulating receiver on board the user spacecraft, the output of the DRS system reference architecture in the forward direction corresponds to the output of the demodulator on board the user satellite. For the case of a repeater on board the user spacecraft, it corresponds to the output of the earth station demodulator receiving the return feeder link signal.

In the return direction, the input to the DRS reference architecture corresponds to the input of the user spacecraft modulator carrying out the translation from the baseband to the radio-frequency carrier. This baseband data typically consists of real-time and/or recorded scientific data, or for manned missions, voice and video information. The output of the reference architecture corresponds to the output of the earth station demodulator carrying out the reverse operation.

3 Frequency bands and transmission directions

Each of the DRS system architecture links defined in § 2 must necessarily transmit in a separate frequency band, with a guard band between the signals transmitted from and those received by the data relay satellite. In determination of the frequency bands for these links, there are many factors to consider. These include the allocation status and bandwidth of available bands, antenna beam width and propagation characteristics. It is noted that the choice of a common frequency band for different data relay satellite networks/systems requires the consideration of interoperability between user spacecraft designed to use one DRS system and data relay satellites of another DRS system.

For the forward and return inter-orbit links, the characteristics of the wide variety of different types of DRS users dictate the use of multiple bands. Some DRS user spacecraft require links of low data rate (up to about 6 Mbit/s) which require modest bandwidths, and can be most economically implemented using low-power transmitters and simple wide-beam antennas without complex pointing mechanisms along with robust receivers. Some other DRS user spacecraft require links from wide-beam or omnidirectional antennas (in particular to support contingency links) in cases where the attitude of the user spacecraft and the direction of the DRS is not accurately known. For these classes of DRS users, the use of inter-orbit link frequencies below 3 GHz is ideal. Other DRS user spacecraft require links of medium to high data rates (from about 6 Mbit/s up to 600 Mbit/s) and therefore require the use of frequency bands for DRS inter-orbit links above 10 GHz.

For the forward and return feeder links, it is noted that DRS systems could use either frequency bands allocated for the fixed satellite service or those allocated for the space research service and that there are a number of bands allocated with sufficient bandwidth to support the data transfer requirements of the inter-orbit links as described above. For nominal DRS satellite operations, these bands are also appropriate for DRS spacecraft command and telemetry. However for the launch, early-orbit-phase and emergency operations of DRS satellites, where omnidirectional antennas may be needed, a frequency band below 3 GHz is preferred.