

## RECOMMENDATION ITU-R SA.1414

**CHARACTERISTICS OF DATA RELAY SATELLITE SYSTEMS**

(Questions ITU-R 117/7, ITU-R 118/7 and ITU-R 135/7)

(1999)

The ITU Radiocommunication Assembly,

*considering*

- a) that data relay satellite (DRS) systems operate as described in Recommendation ITU-R SA.1018 – Hypothetical reference system for systems comprising data relay satellites in the geostationary orbit and user spacecraft in low-Earth orbits;
- b) that there is an increase in mission requirements and in space research activity conducted particularly in low-Earth orbit;
- c) that DRS provide support to many programmes/missions in the space research service and are vital to supporting both manned and unmanned space research telecommunications;
- d) that it is necessary to establish relevant criteria for sharing between DRS systems and other services operating in co-frequency bands;
- e) that the technical characteristics of representative DRS systems need to be considered in order to derive relevant sharing criteria,

*recommends*

- 1** that the characteristics of DRS systems, as described in Annex 1, may be used in interference sharing studies;
- 2** that the information provided in Annex 1 also be used as a guidance for deriving sharing criteria and coordination thresholds as appropriate for DRS systems.

## ANNEX 1

TABLE 1

## Forward Earth-to-DRS feeder link characteristics

<i>Transmitting earth station</i>				
Network	Russia	United States of America	Europe	Japan
Location	Russia	United States of America <sup>(1)</sup>	Europe	Japan
Frequency range (GHz)	14.5-15.34 selectable	14.5-15.34 selectable	28.6-29.8 selectable	29.5-31 selectable
Link description	Composite <sup>(2)</sup>	Composite <sup>(2)</sup>	Decentralized <sup>(3)</sup>	Decentralized <sup>(3), (4)</sup>
Transmission rate	≤ 256 kbit/s	≤ 51Mbit/s	≤ 10 Mbit/s	≤ 50 Mbit/s
Modulation	FM(TV), PSK	PSK	PSK	
Polarization	Circular	Linear	Linear	Circular
Antenna size (m)	16	18.3	3 and 9	5, 9.2 and 13
Tx antenna gain (dBi)	62	66.4	57.6 and 67.6	63, 68.2 and 71.4
Tx antenna radiation pattern	RR Appendix S7			
Necessary bandwidth (MHz)	≤ 50.5	650 (composite)	≤ 100	≤ 978 (composite)
Maximum power density (dB(W/Hz))	-56	-58	-38	-32.5
Maximum e.i.r.p. density (dB(W/Hz))	4	8.4	19.6	38.9
<i>Receiving DRS</i>				
Orbital locations	Rec. ITU-R SA.1275 or Rec. ITU-R SA.1276			
Antenna size (m)	1.6	2.2	0.4	2.0
Rx antenna gain (dBi)	43	47	40.2	53
Rx antenna radiation pattern	Rec. ITU-R S.672			
System noise temperature (K)	1 500	2 537	1 305	890 and 579
Link availability (%)	99.99		99.9	99.9
Interference criterion	Rec. ITU-R SA.1155			

<sup>(1)</sup> The earth station for the United States of America network is located in White Sands (New Mexico). The coordinates of the station are: 32.5° N, 106.60° W.

<sup>(2)</sup> The composite link for the Russian network comprises one TV analogue channel and four sub-carriers to transmit digitally, a voice channel, a ranging channel and two data channels. The composite link for the United States of America network is composed of seven channels: One DRS command and ranging channel, one DRS pilot tone signal, one S-band (2 GHz) multiple access (S-MA) link, two S-band single access (S-SA) links and two Ku-band (14/11 GHz and 30/20 GHz) single access (K-SA) links.

<sup>(3)</sup> The European DRS ground system consists of 12 earth stations, including the TT&C earth station, located in different countries within Europe. The earth station communicates with the DRS through its European coverage antenna.

<sup>(4)</sup> The Japanese network employs a decentralized link concept that permits independent forward feeder links from different earth stations

TABLE 2  
Forward DRS-to-spacecraft link characteristics

<i>Transmitting DRS</i>									
Network	United States of America	Europe	Japan	United States of America	Russia	United States of America	Europe	Japan	United States of America
Orbital locations	Rec. ITU-R SA.1275 or Rec. ITU-R SA.1276								
Frequency range (GHz)	2 ~ 2.1	2.025-2.11 <sup>(1)</sup>			13.4-13.8		22.55-23.55		
Link description	Multiple access (S-MA) link	Single access (S-SA) link			Single Access (Ku-SA) link		Single Access (Ka-SA) link		
Transmission rate (bit/s)	≤ 300 kbit/s	≤ 1 Mbit/s	≤ 6 Mbit/s	≤ 300 kbit/s	≤ 256 kbit/s	≤ 25 Mbit/s (US)	≤ 10 Mbit/s	≤ 50 Mbit/s	≤ 25 Mbit/s
Modulation	SQPN/PSK <sup>(2)</sup>				FM(TV), PSK	PSK			
Polarization	Circular								
Antenna size (m)	Phased array	2.8	3.6	4.9	3	4.9	2.8	3.6	4.9
Tx antenna gain (dBi)	23	34	36.4	36.6	49	53.8	53.4	57.4	58.9
Tx antenna radiation pattern	Rec. ITU-R S.672								
Necessary bandwidth (MHz)	≤ 6	≤ 6	30	20	≤ 50.5	50	60	≤ 150	50
Maximum power density (dB(W/Hz))	-54	-54.7	-44.5	-64	-67	-67.7	-65.1	-49.5	-64.5
Maximum e.i.r.p. density (dB(W/Hz))	-31 (US)	-20.7	-8.1	-24.7	-18	-13.9	-11.7	-7.9	-5.6

TABLE 2 (continued)

<i>Receiving spacecraft</i>									
Network	United States of America	Europe	Japan	United States of America	Russia	United States of America	Europe	Japan	United States of America
Orbital locations	Mainly low-Earth orbit								
Frequency range (GHz)	2 ~ 2.1	2.025-2.11 <sup>(1)</sup>			13.4-13.8		22.55-23.55		
Antenna size (m)	Omnidirectional, arrays	Omnidirectional, arrays, parabolic = $\leq 1.5$			$\leq 1.5$		$\leq 1.3$		$\leq 1.3$
Rx antenna gain (dBi)	$\leq 1.5$	$\leq 27.3$	$\leq 27.1$	$\leq 27.3$	$\leq 44$		$\leq 47$	$\leq 48.9$	$\leq 47$
Rx antenna radiation pattern		Rec. ITU-R S.672 for high gain antenna			Rec. ITU-R S.672				
System noise temperature (K)	600	600	680	600	1 000		1 400	850	1 400
Required $E_b/N_0$ (dB)	~10	9.5	10.5	9.5	9.5		9.5	10.8	9.5
Required BER	$1 \times 10^{-5}$	$1 \times 10^{-6}$							
Link reliability (%)	99.99	99.9		99.99			99.9		99.99
Interference criterion	Rec. ITU-R SA.1155								

SQPN: Staggered quadriphase pseudo-random noise

(1) Transmit frequency is selectable in 5 MHz steps.

(2) Signals with low data rate transmissions will be spread by a pseudo-random noise code so as to meet pfd limits.

TABLE 3  
Return spacecraft-to-DRS link characteristics

<i>Transmitting spacecraft</i>									
Network	United States of America	Europe	Japan	United States of America	Russia	United States of America	Europe	Japan	United States of America
Orbital locations	Mainly low-Earth orbit								
Frequency range (GHz)	2.285-2.290	2.200-2.290 <sup>(1)</sup>			14.76-15.34		25.25-27.50		
Link description	Multiple access (S-MA) link	Single access (S-SA) link			Single access (Ku-SA) link		Single access (Ka-SA) link		
Transmission rate	≤ 3 Mbit/s	≤ 1 Mbit/s	≤ 12 Mbit/s	≤ 6 Mbit/s	≤ 512 kbit/s	≤ 300 Mbit/s	≤ 150 Mbit/s	≤ 300 Mbit/s	≤ 800 Mbit/s
Modulation	SQPN/PSK <sup>(2)</sup>				FM, PSK		PSK		
Polarization	Circular								
Antenna size (m)	Omnidirectional, arrays	Omnidirectional, arrays, parabolic = ≤ 1.5			≤ 1.5		≤ 1.9	≤ 1.5	
Tx antenna gain (dBi)	≤ 15	≤ 27.3	≤ 27.6	≤ 27.3	≤ 43		≤ 47	≤ 49.7	≤ 47
Tx antenna radiation pattern		Rec. ITU-R S.672 for high gain antenna			Rec. ITU-R S.672				
Necessary bandwidth (MHz)	6	≤ 6	20	12	≤ 50.5	≤ 225	≤ 300	≤ 300	≤ 300
Maximum power density (dB(W/Hz))	-34	-51	-55.7	-38.6		-19	-65.1	-58.8	
Maximum e.i.r.p. density (dB(W/Hz))	Compliant with pfd limits						-23	-9.1	

TABLE 3 (continued)

<i>Receiving DRS</i>									
Network	United States of America	Europe	Japan	United States of America	Russia	United States of America	Europe	Japan	United States of America
Orbital locations	Recs. ITU-R SA.1275 or ITU-R SA.1276								
Frequency range (GHz)	2.285-2.290	2.200-2.290 <sup>(1)</sup>			14.76-15.34		25.25-27.50		
Antenna size (m)	Phased array	2.8	3.6	4.9	3	4.9	2.8	3.6	4.9
Rx antenna gain (dBi)	29	34.7	37.2	36	49	53.3	53.4	58.8	58
Rx antenna radiation pattern	Rec. ITU-R S.672								
System noise temperature (K)	525	590	404	617	680	907	1 305	475	
Link reliability (%)	99.99		99.9	99.99			99.9		99.99
Interference criterion	Rec. ITU-R SA.1155								

<sup>(1)</sup> Transmit frequency is selectable in 5 MHz steps, 100 kHz steps for Japanese DRS.

<sup>(2)</sup> Signals with low data rate transmissions will be spread by a pseudo-random noise code so as to meet pfd limits.

TABLE 4

## Return DRS-to-Earth feeder link characteristics

<i>Transmitting DRS</i>				
Network	Russia	United States of America	Europe	Japan
Orbital locations	Recs. ITU-R SA.1275 or ITU-R SA.1276			
Frequency range (GHz)	10.7-10.95	13.4-14.05	18.1-21.2	19.7-21.2
Link description	Ku-band (14/11 GHz) return feeder		Ka-band (30/20 GHz) return feeder	
Transmission rate (kbit/s)	≤ 512	(1)	(2)	(2)
Modulation	FM, PSK	PSK		SQPN/PSK
Polarization	Circular	Linear		Circular
Antenna size (m)	1.6	2	0.4	2.0
Tx antenna gain (dBi)	43	46.1	40.2	49.5
Tx antenna radiation pattern	Rec. ITU-R S.672			
Necessary bandwidth (MHz)	≤ 50.5	650 (composite), 225 (dedicated)	≤ 300	839
Maximum power density (dB(W/Hz))	-66	-57	-61	-40.9
Maximum e.i.r.p. density (dB(W/Hz))	-23	-10.9	-20.8	8.6
<i>Receiving earth station</i>				
Location	Russia	United States of America	Europe	Japan
Antenna size (m)	16	18.3	3, 9	5, 9.2 and 13
Rx antenna gain (dBi)	62	65.5	54, 63.9	59.5, 67.7
Rx antenna radiation pattern	RR Appendix S7			
System noise temperature (K)	160	300	795	200
Link availability (%)	99.99		99.9	
Interference criterion	Rec. ITU-R SA.1155			

(1) The United States of America DRS transmits a dedicated and a composite link. Transmission rate for the dedicated link is 300 Mbit/s, for the composite link the transmission rate is on the order of 630 Mbit/s.

(2) The European and Japanese networks employ a decentralized link concept that permits independent return feeder links to different earth station.