Space Frequency Coordination Group

Recommendation SFCG 42-1

FREQUENCY CHANNEL PLAN FOR IN-SITU LUNAR DATA RELAY SATELLITES

The SFCG,

CONSIDERING

a)   that data relay services are needed to support the increasing number of missions planning to operate in the lunar region;

b)   that a lunar relay frequency channel plan is needed to ensure interoperability and avoid unwanted interference from lunar data relay services with other lunar spectrum users;

c)   that the 2 025 – 2 110 MHz and 2 200 – 2 290 MHz bands have been recommended[1] by the SFCG for in-situ lunar links;

d)   that CCSDS Proximity-1 protocol[2] or the LunaNet Interoperability Specification[3] (LNIS) may be used for lunar relay communications and navigation services;

e)   that the 23 150 – 23 550 MHz and 27 000 – 27 500 MHz bands have been recommended[1] by the SFCG for in-situ lunar links requiring higher bandwidths;

f)   that the CCSDS Proximity-1 protocol is a single access service, while LNIS provides for single access and multiple access services in the 2 GHz band, and single access service in the 23/27 GHz bands;

g)   that the LNIS multiple access service is based on Code Division Multiple Access (CDMA), which allows for multiple simultaneous users to share the same frequency channel;

h)   that, a contiguous frequency range in the lunar relay channel plan will provide greater flexibility to accommodate relay users with differing data rates and bandwidths;

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[1] SFCG Recommendation 32-2R5 or latest revision
[2] CCSDS 211.1-B-4 or latest revision
[3] LunaNet Interoperability Specification Document, Version 4 or latest revision

i)   that the forward (relay-to-user) and return (user-to-relay) frequency channels may be coherently linked using the turnaround ratio for radionavigation purposes;

j)   that antenna polarization may be used to increase spectrum utilization for the lunar relay channels, particularly in the congested 2 GHz band;

NOTING

that, depending on the number of lunar relay users and their bandwidth requirements, additional frequency channels may need to be added to this Recommendation in the future;

RECOMMENDS

1.   that, for single access services in the 2 GHz band, lunar data relay systems use the frequency ranges in Table 1;

Table 1. 2 GHz Lunar Relay Single Access Frequencies

Single Access Forward Service (relay to user)	Single Access Return Service (user to relay)
2065.8354 – 2078.8354 MHz	2244 – 2257 MHz
2084.1083 – 2089.1083 MHz [*]	2263.5 – 2268.5 MHz [*]
2095.1583 – 2100.1583 MHz [**]	2275.5 – 2280.5 MHz [**]

[*] This frequency range shall be accessed using the Proximity-1 protocol[2] with the frequency channels defined in Table 3 below
[**] This frequency range may optionally be accessed by Proximity-1 users with the frequency channels defined in Table 3 below

2.   that, for multiple access services in the 2 GHz band, lunar data relay systems use the frequency channels in Table 2;

Table 2. Lunar Relay Multiple Access Frequency Channel

Multiple Access Forward Service (relay to user)	Multiple Access Return Service (user to relay)
2059.20625 – 2065.20625 MHz	2236.5 -2242.5 MHz

3.   that, for CCSDS Proximity-1 single access services in the 2 GHz band, the Prox-1 channel frequencies defined in Table 3 should be used;

Table 3. Proximity-1 S-band Channel Center Frequencies

Channel Number	Prox-1 S-band Forward Channel (MHz)	Prox-1 S-band Return Channel (MHz)
0 (primary hailing channel)	2084.766667	2264
1	2085.6875	2265
2	2086.608333	2266
3	2087.529167	2267

4	2088.45	2268
5	2095.816667	2276
6	2096.7375	2277
7	2097.658333	2278
8	2098.579167	2279
9 (secondary hailing channel)	2099.5	2280

4.   that, for single access services in the 23/27 GHz bands, lunar data relay systems use the frequency ranges in Table 4;

Table 4. 23/27 GHz Lunar Relay Single Access Frequencies

Single Access Forward Service (relay to user)	Single Access Return Service (user to relay)
23200.7173 – 23400.7173 MHz	27160 – 27360 MHz

5.   that, for coherent forward and return channels, lunar data relay systems use the 240/221 turnaround ratio for the 2/2.2 GHz band, and the 2816/2407 turnaround ratio for the 23/27 GHz bands;

6.   that lunar data relay systems use either right-hand circular or left-hand circular antenna polarization[4].

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[4] Note that for the Proximity-1 channels, left-hand circular antenna polarization is used for hailing on Channel 0 and right-hand circular antenna polarization is used for hailing on Channel 9. Right-hand or left-hand circular polarization can be used on Channels 1-8.