Geostationary Operational Environmental Satellite (GOES)

GOES-R Series

Interface Requirements Document (IRD)

Space Segment (SS)
To
Data Collection System (DCS)

Draft

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To verify the correct version of this document, please contact the GOES R Series Requirements Management Office on 301-286-7898

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1 Introduction

The Geostationary Operational Environmental Satellite Series R (GOES-R) System will provide an expanded capability series of spacecraft to follow those developed and launched under the GOES N-Q Program. The expanded capabilities will follow from anticipated developments of the payload instrument suites as well as the several ancillary services included in the program mission. Six GOES-R Mission Segments interface and function to support the total GOES-R mission. They are:

- **Space Segment (SS)**
- Launch Support Segment (LSS)
- Ground Located - Command, Control, and Communications Segment (GL-C3S)
- Product Generation and Distribution Segment (PGDS)
- User Interface Segment (UIS)
- Archive and Access Segment (AAS)

As part of the Space Segment (SS), the GOES-R will support several NOAA auxiliary services:

- GOES Rebroadcast Service (GRB)
- Low Rate Information Transmission (LRIT) Service
- Emergency Managers Weather Information Network (EMWIN) Service
- **Data Collection System (DCS)**
- Search and Rescue (SAR) Service

1.1 Purpose

The purpose of this document is to describe and specify the functional and performance interface requirements for the communication links between the GOES-R Space Segment (SS) and the Data Collection System (DCS).
This document it also intended to provide a basis for the subsequent development of a SS-DCS Interface Control Document (ICD).

1.2 Scope

The interfaces addressed in this document support the exchange of data between the SS and the DCS ground segment.
Only those parameters which are necessary to specify the interface requirements will be referenced here; specifications for the satellite transponder will be contained in a satellite performance specification. This IRD therefore:
Identifies required RF links between the SS and the DCS ground segment
Establishes functional and performance requirements related to these links

1.3 Document Overview

This document contains six Sections and two Appendices.
Section 1 explains the purpose and scope of the IRD. It contains a list of applicable and reference documents relevant to the interface.
Section 2 describes the DCS system functional elements that must be supported by the subject interfaces. Section 3 contains describes the characteristics of the DCS platforms

relevant to the interface with the GOES-R Space Segment. Section 4 describes the relevant characteristics of the Direct Readout Ground Stations (DRGS) and the Command and Data Acquisition Stations (CDAS).
Section 5 provides the functional and performance requirements that must be met by the SS to support the link interfaces.
Section 6 specifies the overall link performance that must be met under specified assumptions.
Section 7 lists "To Be Determined" (TBD) and "To Be Reviewed" (TBR) parameters and issues in the IRD.
Section 8 lists abbreviations and acronyms used in the IRD.

1.4 Reference Documents

The following documents [1] through [6] are useful references about the DCS Service.
[1] An Impact Study of Higher Transmission Rates through the GOES Data Collection System - Final Report, G. A. Fay and P. M. McManamon, Cyberlink Corporation, 30 January 1989
[2] GOES Data Collection System Radio Set (DCPRS) Certification Standards, NOAA/NESDIS, October 1992 [superceding earlier document of November 1981][includes 100 bit/s service only]
[3] The Geostationary Operational Environmental Satellite Data Collection System, NOAA Technical Memorandum NESDIS 40, June 1994
[4] National Geostationary Operational Environmental Satellite Data Collection System Operations Plan, FCM-P28-1997, August 1997
[5] GOES Data Collection System (DCS) System Characterization Report [Preliminary], Mitretek Systems Inc., 3 June 1998
[6] Version 1.0B of the 300/1200 BPS GOES Data Collection Platform Radio Set (DCPRS) CERTIFICATION STANDARDS, NOAA/NESDIS, March 2000
Information in the specification for the communication parameters used for the preceding series of GOES satellites, the GOES-N Series, is also of use, particularly for areas not well covered by the DCS documents:
[7] Performance Specification for the GOES-N,O,P,Q, S-415-22, Attachment B, Table 10, 27 August 1997, NASA/GSFC]
[8] GOES N-Q Space-to-Ground Interface Control Document, Doc. No. DS80667-H00-003, Version 1.0, 31 March 1999, prepared by Hughes Space and Communications Co., prepared for NASA GSFC
The following document contains information about the capabilities of the NOAA Command and Data Acquisition Stations (CDAS):
[9] NOAA/NESDIS Antennas and RF System Capabilities Handbook, NOAA/OSD3-2001-0043R0UD0, 10 August 2001

2 Data Collection Service (DCS) and Interface Description

2.1 General Description

The GOES support to the Data Collection System (DCS) is provided by GOES satellites located at 75º and 135º W. Longitude. This system provides a bidirectional link connectivity between a large number of outlying Data Collection Platforms (DCP) and the NOAA Command and Data Acquisition Stations (CDAS) and/or Direct Readout Ground Stations (DRGS). These DCP are typically small remote monitoring stations used for the collection and reporting of near real-time environmental data. DCP may be located on aircraft, ships, balloons, and fixed sites and collect a wide variety of data (e.g., seismic, water level, wave state, snow and ice cover, etc.). The satellite access methods include either random, scheduled access, or interrogate/report.

Inbound messages from the DCP to the CDAS and/or DRGS, containing the reported data, are called Data Collection Platform Report (DCPR) messages. These are relayed through the GOES-R satellite by a separate DCPR transponder. The user data rates are 100, 300, or 1200 bit/s.

Outbound link connections from the CDAS to a specific DCP, for purposes of initiating a data transfer, are called Data Collection Platform Interrogate (DCPI) messages. In the GOES-R satellite these are received and transponded in a dedicated DCPI transponder. The user data rate is 100 bit/s.

Although all DCP must be capable of transmitting DCPR, only a relatively small fraction of the DCP are currently capable of receiving and processing DCPI messages. Most rely on scheduled or locally generated requests to initiate data reporting. This present system characteristic may change during the period when GOES-R becomes operational to include a higher percentage of platforms that include DCPI capability.

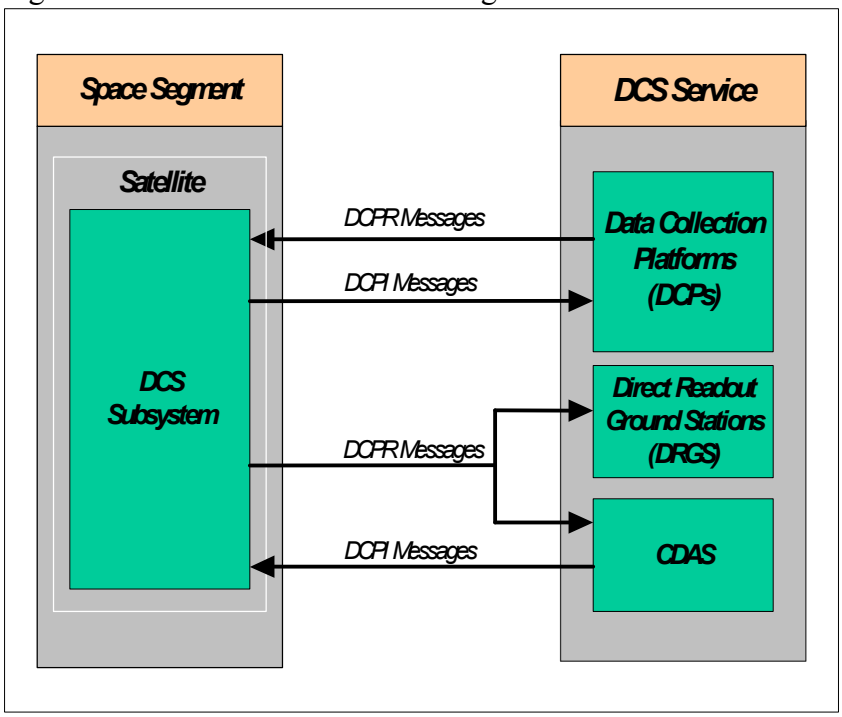
Both satellite transponders are bent-pipe, i.e., receiving the uplinks within a certain frequency band, translating to a new frequency band, amplifying, and retransmitting on the downlink, but with no other processing. For the DCPR link, the uplink is UHF and the downlink is L-Band; for the DCPI link, the uplink is S-Band and the downlink is UHF. In each case, the satellite antenna must provide earth coverage out to a ground station elevation angle of 5º

The DCPR transmissions are channelized FDMA with a total of 233 channels available. The first 200 of these are of 1.5 kHz bandwidth and are used for 100/300 bit/s service. The remaining 33 channels are of 3 kHz bandwidth and are assigned to the 1200 bit/s service. The channel center frequencies are given in Section 3.2.

The DCPI transmissions use three channels, designated GOES-East, GOES-West, and GOES-Spare.

Figure 2-1 shows the SS-to-DCS interface. The required connectivity through the GOES-R Series satellites is shown in Figure 2-2. Not shown in this figure are other links that support downlinking of the instrument data (Sensor Data or SD) and the transponder support to the other ancillary services.

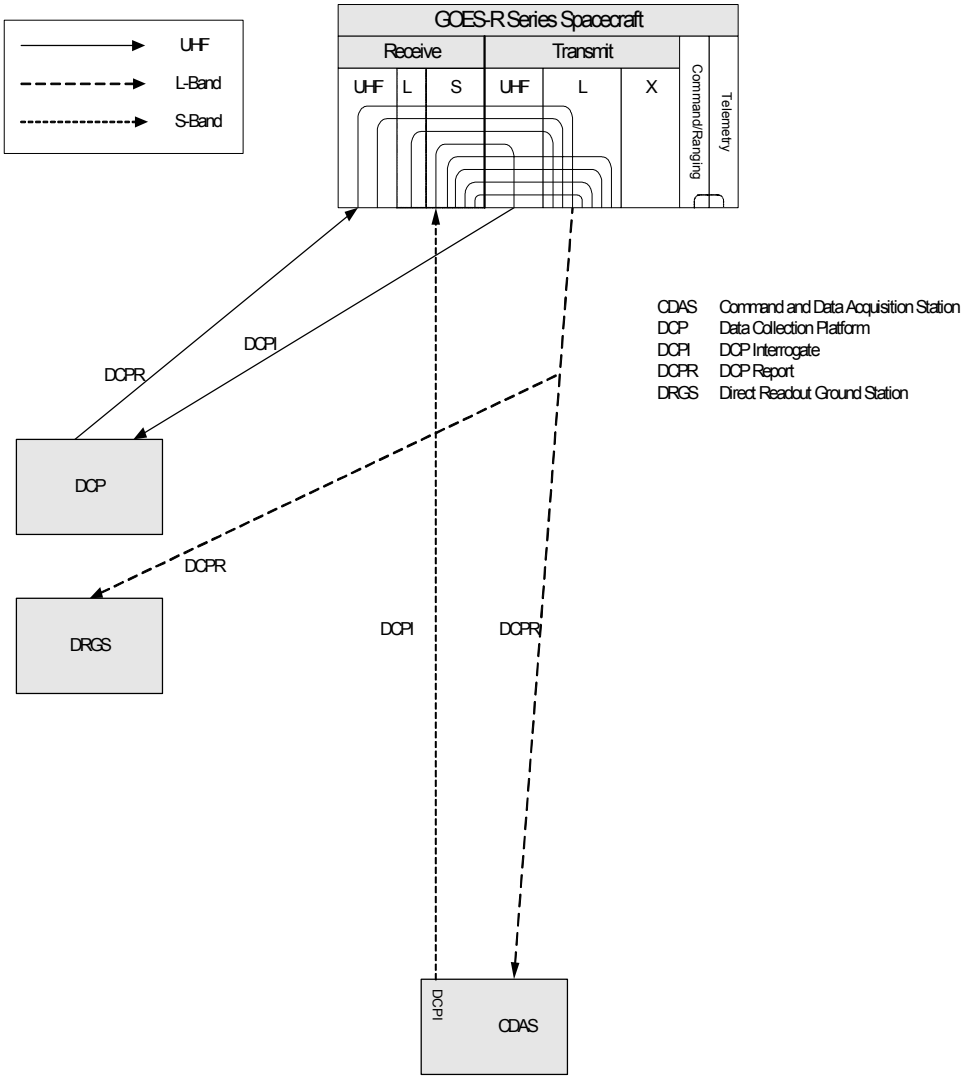
Figure 2-1: SS-to-DCS Interface Diagram



3 Data Collection Platform Requirements

3.1 Introduction and Functional Elements

Figure 2-2: DCS Connectivity through GOES-R Series Satellites



As indicated in Section 2.1, the Data Collection Platforms (DCP's) provide a UHF transmission capability for the transmission of short data messages (DCPR) through the GOES satellite transponder to the receiving ground stations, either Direct Readout Ground Stations (DRGS) or the CDAS. An optional capability exists at the DCP's for the reception of an outbound interrogate message (DCPI) addressed to individual DCP's from the CDAS. The inbound transmissions (DCP-to-DRGS/CDAS) are at a 100, 300, or 1200 bit/s transmission rate. The outbound transmissions (CDAS-to-DCP) are at a 100 bit/s transmission rate. Only those elements necessary for specifying the SS-to-DCS

interface will be addressed here. Additional information is available in the applicable and reference documents (Sections 1.4 and 1.5).
The two separate message paths, DCPR and DCPI, will be covered separately.

3.2 Data Collection Platform - Report (DCPR) Channel

3.2.1 Frequency Channelization

The DCP uplink frequencies are one of 233 channels. The first 200 of these channels are contiguous and of 1.5 kHz bandwidth; the remaining 33 channels are contiguous and of 3.0 kHz bandwidth. The 1.5 kHz channels (i.e., channels 1 to 200) are used for the transmission of 100 and 300 bit/s transmissions; the 3 kHz channels (denoted by the even numbers 202 to 266) are reserved for the 1200 bit/s transmissions. To allow additional guard band between the uplink signals and also because the broad uplink antenna pattern of the DCP's can illuminate both east and west GOES satellites, odd numbered channels (1 to 199) are assigned to the GOES east satellite (75º W) and even numbered channels (2 to 200) are assigned to the GOES west satellite (135º W). Channels 1 to 200 are called "domestic" channels; channels 202 to 266 (even only) are called "international" channels and are shared with other international systems (e.g., METEOSAT, GMS, and Russia). The channel center frequencies are shown in Table 3-1.

Table 3-1: DCS Frequency Channelization

Domestic DCS Channels							
Channel Number	Center Frequency (MHz)	Channel Number	Center Frequency (MHz)	Channel Number	Center Frequency (MHz)	Channel Number	Center Frequency (MHz)
1	401.7010	51	401.7760	101	401.8510	151	401.9260
2	401.7025	52	401.7775	102	401.8525	152	401.9275
3	401.7040	53	401.7790	103	401.8540	153	401.9290
4	401.7055	54	401.7805	104	401.8555	154	401.9305
5	401.7070	55	401.7820	105	401.8570	155	401.9320
6	401.7085	56	401.7835	106	401.8585	156	401.9335
7	401.7100	57	401.7850	107	401.8600	157	401.9350
8	401.7115	58	401.7865	108	401.8615	158	401.9365
9	401.7130	59	401.7880	109	401.8630	159	401.9380
10	401.7145	60	401.7895	110	401.8645	160	401.9395
11	401.7160	61	401.7910	111	401.8660	161	401.9410
12	401.7175	62	401.7925	112	401.8675	162	401.9425
13	401.7190	63	401.7940	113	401.8690	163	401.9440
14	401.7205	64	401.7955	114	401.8705	164	401.9455
15	401.7220	65	401.7970	115	401.8720	165	401.9470
16	401.7235	66	401.7985	116	401.8735	166	401.9485
17	401.7250	67	401.8000	117	401.8750	167	401.9500
18	401.7265	68	401.8015	118	401.8765	168	401.9515
19	401.7280	69	401.8030	119	401.8780	169	401.9530
20	401.7295	70	401.8045	120	401.8795	170	401.9545
21	401.7310	71	401.8060	121	401.8810	171	401.9560
22	401.7325	72	401.8075	122	401.8825	172	401.9575
23	401.7340	73	401.8090	123	401.8840	173	401.9590
24	401.7355	74	401.8105	124	401.8855	174	401.9605
25	401.7370	75	401.8120	125	401.8870	175	401.9620
26	401.7385	76	401.8135	126	401.8885	176	401.9635
27	401.7400	77	401.8150	127	401.8900	177	401.9650
28	401.7415	78	401.8165	128	401.8915	178	401.9665
29	401.7430	79	401.8180	129	401.8930	179	401.9680
30	401.7445	80	401.8195	130	401.8945	180	401.9695
31	401.7460	81	401.8210	131	401.8960	181	401.9710
32	401.7475	82	401.8225	132	401.8975	182	401.9725
33	401.7490	83	401.8240	133	401.8990	183	401.9740
34	401.7505	84	401.8255	134	401.9005	184	401.9755
35	401.7520	85	401.8270	135	401.9020	185	401.9770
36	401.7535	86	401.8285	136	401.9035	186	401.9785
37	401.7550	87	401.8300	137	401.9050	187	401.9800
38	401.7565	88	401.8315	138	401.9065	188	401.9815
39	401.7580	89	401.8330	139	401.9080	189	401.9830
40	401.7595	90	401.8345	140	401.9095	190	401.9845

41	401.7610	91	401.8360	141	401.9110	191	401.9860
42	401.7625	92	401.8375	142	401.9125	192	401.9875
43	401.7640	93	401.8390	143	401.9140	193	401.9890
44	401.7655	94	401.8405	144	401.9155	194	401.9905
45	401.7670	95	401.8420	145	401.9170	195	401.9920
46	401.7685	96	401.8435	146	401.9185	196	401.9935
47	401.7700	97	401.8450	147	401.9200	197	401.9950
48	401.7715	98	401.8465	148	401.9215	198	401.9965
49	401.7730	99	401.8480	149	401.9230	199	401.9980
50	401.7745	100	401.8495	150	401.9245	200	401.9995
International DCS Channels (3 kHz BW)							
202	402.0025	222	402.0325	242	402.0625	262	402.0925
204	402.0055	224	402.0355	244	402.0655	264	402.0955
206	402.0085	226	402.0385	246	402.0685	266	402.0985
208	402.0115	228	402.0415	248	402.0715		
210	402.0145	230	402.0445	250	402.0745		
212	402.0175	232	402.0475	252	402.0775		
214	402.0205	234	402.0505	254	402.0805		
216	402.0235	236	402.0535	256	402.0835		
218	402.0265	238	402.0565	258	402.0865		
220	402.0295	240	402.0595	260	402.0895		

[NOTE added in DRAFT: The above channelization reflects the information in [3]; a slightly different channel numbering configuration is reflected in [6]. Among other things, the channelization in [6] indicates 3 kHz channels may be formed by combining 1.5 kHz channels in the band 401.7 to 402.0 MHz. Both documents reflect the operational bandwidth of 401.7 to 402.1 MHz (i.e., a 400 kHz band). This subject should be clarified within the NOAA documents.]

3.2.2 Frequency Accuracy and Long-Term Stability

For the 100 bit/s transmission terminals, the transmit frequency **shall** be adjustable to ±100 Hz [2]. For the 300/1200 bit/s terminals, the transmit frequency shall be adjustable to ±25 Hz [6].

For the 100 bit/s terminals, the transmit frequency stability **shall** be less than ±0.5 ppm over a temperature range of -40ºC to +50ºC. The long term stability (including temperature variations) shall be less than ±1 ppm per year (Note: No maximum value of drift is specified over a terminal's operational life [2]). At this time, no new 100 bit/s terminals are being authorized.

For the 300/1200 bit/s terminals, the combined lifetime frequency stability under all conditions of temperature and power supply variation shall be less than ±1 ppm. This is interpreted to imply that the output frequency **shall** be maintained to an accuracy of ± 425 Hz (i.e., approximately 1 ppm) [6].

3.2.3 Short-Term Frequency Stability and Phase Noise

For the 100 bit/s service there is no short term stability requirement [2]. For the 300/1200 bit/s service the short-term frequency stability is specified as ± 1 Hz/s under any combination of power supply variation (± 15%) or temperature (-40 C to +50 C) [6]. For the 100 bit/s service, the integrated phase noise on the transmit carrier **shall** be less than 3º RMS when measured through a phase-lock-loop (PLL) with two sided noise bandwidth of 20 Hz and within 2 kHz [2]. The phase noise specification for the 300/1200 bit/s service is < 2.5ºRMS under conditions given in [6].

3.2.4 Effective Isotripic Radiated Power (EIRP)

For the 100 bit/s terminals, the EIRP is specified as a maximum value of 50 dBm, but with no minimum value [3].
For the 300/1200 bit/s terminals, the EIRP is specified for any combination of power supply voltage and temperature variation as follows:

Data Rate (bit/s)	Nominal EIRP (dBm)	Maximum EIRP (dBm)
300	48	50
1200	51	53

For the GOES-N Series system design, a minimum EIRP of 45 dBm was specified [8, Table 10].

3.2.5 Polarization

The DCP transmit polarization is specified as RHCP. For the 300/1200 bit/s terminals, the on-axis axial ratio is specified to be ≤ 6 dB [6]. For the 100 bit/s terminals, the on-axis axial ratio is specified to be ≤ 8 dB [2].

3.2.6 Modulation

3.2.6.1 Data Rate

The transmission data rate is either 100, 300, or 1200 bits/s. New terminals are no longer being authorized using the 100 bit/s rate.

3.2.6.2 100 Bit/s Data Encoding and Modulation

The data is Manchester encoded with a format described in reference document [2]. This encoded format is used to phase modulate a carrier with a ± 60ºcarrier phase shift.

3.2.6.3 300/1200 Bit/s Data Encoding and Modulation

The modulation is 8PSK using a convolutional/trellis encoder [6].

3.3 Data Collection Platform - Interrogate (DCPI) Channel

3.3.1 Frequency Channelization

The downlink frequency for the DCPI consists of a single 0.4 kHz bandwidth channel at the following center frequency[6]:

Satellite	Channel Center Frequency (MHz)
GOES-East	468.8375
GOES-West	468.8125 (also used for Spare) or 468.8250

[NOTE for DRAFT: These frequencies are from [3, 6] and disagree with the assignments (but not values) given in [7]].

3.3.2 Frequency Accuracy and Long-Term Stability

[NOTE for DRAFT: These parameters are unspecified in the DCS documents. The value used in the ICD for the GOES-N Series satellites is given in [8] as ±005 MHz (apparently a misprint with an intended value of ±0.005 MHz or 5 kHz). This value needs to be reviewed]

3.3.3 Short-Term Frequency Stability and Phase Noise

[NOTE for DRAFT: These parameters are unspecified in the DCS documents. The phase noise value used for the GOES-N Series system design as given in [8] is ≤ 3ºrms. This value needs to be reviewed].

3.3.4 Platform G/T

[NOTE for DRAFT: This parameter is unspecified in the DCS documents. The G/T values used for the GOES-N Series system design are given in [7] as -21.6 dB/K for land platforms and -29 dB/K for buoys. These values need to be reviewed].

3.3.5 Polarization

[NOTE for DRAFT: This parameter is unspecified in the DCS documents. The polarization used for the GOES-N Series satellites is given in [7] as RHCP with an axial ratio of 6 dB. These parameters need to be reviewed].

3.3.6 Modulation

3.3.6.1 Data Rate

The transmission data rate is 100 bits/s [6].

3.3.6.2 Data Encoding and Modulation

The data encoding is BiΦ-L which is used to phase modulate a carrier with a phase deviation of ± 60º. A single TDMA stream is used to access all DCP's

4 Ground Station Requirements

The inbound DCPR signals may be received at L-Band by either or both the Direct Readout Ground Stations (DRGS) and the NOAA CDAS. For the outbound DCPI, only the CDAS has the capability for transmission.

4.1 Receive (DRGS and CDAS)

4.1.1 Receive Frequency Band

The overall receive frequency band is 1694.3 - 1694.7 MHz for the "Domestic" band and 1694.6 - 1695.0 MHz for the "International" band.

4.1.2 Receive G/T

The DRGS G/T is a minimum of 12 dB/K [7]. This includes any antenna mispointing. Tracking is not required. [An alternate and improved G/T of 15 dB/K was given in an earlier NOAA TRD and could be considered.]
The CDAS G/T is a minimum of 26 dB/K including any tracking loss [10].

4.1.3 Receive Polarization

The antenna polarization **shall** be linear North-South (N-S) with a maximum axial ratio of 2 dB.

4.1.4 Demodulation

The DRGS or CDAS **shall** be capable of phase demodulation of the received satellite signals. Baseband processing of the received data signal is described in reference document [2].

4.2 Transmit (CDAS Only)

4.2.1 Transmit Frequency

The transmit frequencies for the DCPI signals are 2034.8375 MHz for GOES-E, 2034.8125 MHz for GOES-W or the GOES-Spare, and 2034.8250 MHz for GOES-W.

4.2.2 Transmit EIRP

The nominal EIRP for the uplink DCPI signal from the CDAS is [TBD; for the GOES-N Series it was in the range 79.5 to 88.4 dBmi [7]]

4.2.3 Transmit Polarization

The transmit polarization is linear, aligned with the linear polarization of the satellite.

5 Space Segment (SS) Requirements

The Space Segment (SS) requirements consist of
1. [Sec. 5.1 and 5.2] Receiving the uplink 400 kHz wide DCS frequency band in the 401MHz UHF region, translating this band to the 1694 MHz L-Band region, amplifying and transmitting this signal to the DRGS/CDAS ground stations, and
2. [Sec. 5.3 and 5.4] Receiving the uplink DCPI signal in the 2034 MHz S-Band region, translating this signal to the 468 MHz UHF region, amplifying and transmitting this signal to the DCP's.

5.1 DCP-to-SS UpLink Interface

5.1.1 Frequency Band

The uplink frequency band is a nominal 400 kHz bandwidth in the range 401.7 - 402.1 MHz for the "Domestic" band or 402.0 - 402.4 MHz for the "International" band.

5.1.2 Nominal Signal Level

As an informational guideline, the uplink combined signal level from all transmitting DCP's can range from noise alone to a maximum for 233 signals of approximately -100 dBm [8, 9].

5.1.3 Satellite Receive G/T

The satellite receive G/T **shall** be a minimum of -18 dB/K at edge of coverage.

5.1.4 Satellite Receive Antenna Coverage

The satellite beacon receive antenna coverage **shall** be earth coverage with minimum elevation angle of 5°.

5.1.5 Satellite Receive Antenna Polarization

The satellite beacon receive antenna polarization **shall** be RHCP with an axial ratio not to exceed [TBD] dB over the specified coverage area. [NOTE in Draft: GOES-N Series ICD is 2 dB [8]]

5.2 SS-to-DRGS/CDAS Downlink Interface

5.2.1 Frequency Band

The downlink frequency band is a nominal 400 kHz bandwidth in the range 1694.3 - 1694.7 MHz for the "Domestic" band or 1694.6 - 1695.0 MHz for the "International" band.

5.2.2 Satellite EIRP

The downlink EIRP **shall** be a minimum of [TBD] dBmi over the required coverage area. [NOTE in DRAFT: The corresponding value for the GOES-N Series satellites is 46 dBmi [7] or 47.2 - 52.3 dBmi [8].]

5.2.3 Satellite Transmit Antenna Coverage

The downlink satellite beacon transmit antenna coverage **shall** be earth coverage to a minimum elevation angle of 5º.

5.2.4 Satellite Transmit Antenna Polarization

The downlink satellite beacon transmit antenna polarization **shall** be linear N-S with a minimum cross-polarization isolation of [TBD] dB. [NOTE in Draft: GOES-N Series value is unspecified [7].]

5.3 CDAS-to-SS Uplink Interface

5.3.1 Frequency Band

The uplink frequency signal is a narrowband DCPI signal at 2034.8375 MHz for GOES-E, 2034.8125 MHz for GOES-W or the GOES-Spare, and 2034.8250 MHz for GOES-W.

5.3.2 Nominal Signal Level

The uplink signal level at the satellite antenna input is approximately [TBD]. [NOTE in DRAFT: for the GOES-N Series this range is -104 to -114 dBm [7].]

5.3.3 Satellite Receive G/T

The satellite receive G/T **shall** be a minimum of -17 dB/K at edge of coverage.

5.3.4 Satellite Receive Antenna Coverage

The satellite receive antenna coverage **shall** be earth coverage with minimum elevation angle of 5°.

5.3.5 Satellite Receive Antenna Polarization

The satellite receive antenna polarization **shall** be linear N-S with a minimum cross-polarization isolation of [TBD] dB over the specified coverage area. [NOTE in Draft: GOES-N Series value is unspecified [7].]

5.4 SS-to-DCP Downlink Interface

5.4.1 Frequency Band

The downlink frequency for the DCPI consists of a single 0.4 kHz bandwidth channel at the following center frequency:

Satellite	Channel Center Frequency (MHz)
GOES-East	468.8375
GOES-West	468.8125 (also used for Spare) or 468.8250

[NOTE for DRAFT: These frequencies are from [3, 6] and disagree with the assignments (but not values) given in [7]].

5.4.2 Satellite EIRP

The downlink EIRP **shall** be a minimum of [TBD] dBmi over the required coverage area. [NOTE in DRAFT: The corresponding ICD value for the GOES-N Series satellites is 50.1 dBmi [8].]

5.4.3 Satellite Transmit Antenna Coverage

The downlink satellite beacon transmit antenna coverage **shall** be earth coverage to a minimum elevation angle of 5º.

5.4.4 Satellite Transmit Antenna Polarization

The downlink satellite beacon transmit antenna polarization **shall** be RHCP with a minimum cross-polarization isolation of [TBD] dB. [NOTE in Draft: GOES-N Series value is unspecified [7].]

6 Link Performance Specification

Based on the assumed link parameters of Section 6.1, the link performance **shall** meet the performance criteria of Sections 6.2 and 6.3. Performance is specified for the combined up and downlinks, i.e., for the full path between DCP's and the DRGS/CDAS.

6.1 Assumed Link Parameters

The following conditions **shall** be assumed in the calculation of expected link performance.

1. The distribution of DCP EIRP's and data rates present at the satellite input is [TBD].
2. Propagation impairments due to atmospheric absorption and rain of 0.2 dB for the UHF links and 0.5 dB for the L-Band and S-Band links shall be assumed.
3. Scintillation losses **shall** be considered to be 1.5 dB [TBR] for both the up and downlinks; however, it may be assumed that scintillation occurs independently on the up and downlinks and is not simultaneous.
4. Elevation angles at both the DCP and the DRGS/CDAS **shall** be assumed to be the worst case value of 5º.
5. Worst case polarization mismatches on the uplink and downlink **shall** be assumed. Effects of non-ideal axial ratios shall be included.
6. Interference: Co-channel interference for the DCPR links **shall** be assumed small and no specific entry is required. Adjacent channel interference for the DCPR links **shall** assume a two-sided C/I of [further study required; also data rate dependent]. 1. Interference for the DCPI links **shall** be assumed small and no specific entry is required.
7. At the DRGS/CDAS receiver, the required E_b/N_0 **shall** be 10.5 dB [TBR] for the 100 bit/s links and 7.3 dB [TBR] for the 300/1200 bit/s links before applying (a) an implementation loss of 1.2 dB, (b) a modulation loss due to non-orthogonal PSK of 1 dB, and (c) a satellite distortion and other loss of 0.5 dB. [NOTE: loss values TBR].

6.2 Link Availability

The link calculations **shall** demonstrate link closure, i.e., positive link margin, under the assumptions specified in Section 6.1. Due to the benign propagation environment at these frequencies, this should result in link availability of at least 99.9% except for links which may exhibit undue scintillation.

6.3 Link Bit Error Rate

The end-to-end link bit error rate (BER) shall be $1 \cdot 10^{-6}$ or better under the worst-case assumptions of Section 6.1.

7 TBR/TBD Listing

Number (SS/DCS)	Description	Resolution Plan	Date
TBR/TBD1			
TBR/TBD2			
TBR/TBD3			
TBR/TBD4			

8 Abbreviations and Acronyms

ALC	Automatic Level Control
AM	Amplitude Modulation
AS	Archive Segment
β	Modulation Index
BCH	Bose-Chaudhuri-Hocquenghem (Forward Error Correction Code)
BER	Bit Error Rate
BiΦ-L	Bi-Phase Level
BPSK	Binary Phase Shift Keying
BW	Bandwidth or Beamwidth (context dependent)
C3S	Command, Control and Communications Segment
CDA	Command and Data Acquisition
CDAS	Command and Data Acquisition Station
CCSDS	Consultative Committee on Space Data Systems
C/N_0	Carrier to Noise Density Ratio (dB-Hz)
COSPAS	(Russian: Cosmicheskaya Sistyema Poiska Avariynich Sudov) Space System for the Search of Vessels in Distress
CP	Circularly Polarized or Circular Polarization
DCP	Data Collection Platform
DCPI	Data Collection Platform Interrogate
DCPR	Data Collection Platform Report
DCS	Data Collection System
DRGS	Direct Readout Ground Station
EIRP	Effective Isotropically Radiated Power
ELT	Emergency Locator Transmitter
EMWIN	Emergency Managers Weather Information Network
EPIRB	Emergency Position Indicating Radio Beacons
GEOLUT	Geostationary Local User Terminal
GOES	Geostationary Operational Environmental Satellite
GRB-F	GOES Rebroadcast - Full
GRB-L	GOES Rebroadcast - Lite
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
G/T	Gain-to-Noise Temperature Ratio (dB/K)
ICD	Interface Control Document
IRD	Interface Requirements Document
ITU	International Telecommunications Union
L-Band	1.5 – 1.6 GHz Frequency Band
LEO	Low Earth Orbit