ITU Interference Report

RATATOSK-1A (NGSO) × HSD (NGSO)

PREPARED BY

The ODES Team

DATE

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Contents

1 Overview

This report describes the interference analysis results for the victim satellite network **RATATOSK-1A** (NGSO) and the interfering satellite network **HSD** (NGSO).

The interference analysis identified potential interference events during downlink. The largest violation duration was 21 seconds. The largest single-day total time the downlink Carrier to Interference ratio (C/I) margin was negative was 22 seconds (0.03% of a day). ITU-R SA.363 recommends that interference at an earth-station receiver not exceed its threshold for more than 1% of the time each day (864 s). Using a negative C/I margin as a proxy for "interference present", this result is **within** that 1%-of-day guideline. Note that the C/I margin calculations include a 12.2 dB margin, as dictated by the International Telecommunications Union (ITU). In practice, when deciding on whether coordination is neccessary, the parties involved may opt in for a smaller margin. A smaller margin could mean that the intereference events identified are not significant and no further action is required.

Additionally, the interference analysis identified potential interference events during uplink. The largest violation duration was 25 seconds. The largest single-day total time the uplink C/I margin was negative was 25 seconds (0.03% of a day). ITU-R SA.363 recommends that interference at an earth-station receiver not exceed its threshold for more than 1% of the time each day (864 s). Using a negative C/I margin as a proxy for "interference present", this result is **within** that 1%-of-day guideline.

2 Interference Analysis Results

2.1 Downlink worst-case passes

Victim GS Name	Interfering GS Name	Longest Violation (s)	Longest Daily Total (s)
AWARUA	AWARUR	21	21
AWARUA	AWARUR	21	21
ANDOYA	UNST	1	1
AWARUA	AWARUR	20	22
AWARUA	AWARUR	15	15
AWARUA	AWARUR	15	15

TABLE 1 Below-margin time per victim ground station

Victim GS Name	Interfering GS Name	C/I Margin (dB)	C/I (dB)	Required C/I (dB)
AWARUA	AWARUR	-22.3834	3.46353	25.8469
AWARUA	AWARUR	-10.867	0.999575	11.8665
AWARUA	AWARUR	-10.867	-2.00042	8.86653
AWARUA	AWARUR	-5.12594	6.77749	11.9034
AWARUA	AWARUR	-5.12594	6.77749	11.9034
ANDOYA	UNST	-0.555768	31.8304	32.3861
SVALBARD	UNST	6.16428	35.8424	29.6781
ANDOYA	UNST	6.92036	22.7157	15.7953
ANDOYA	UNST	6.92036	19.7157	12.7953
TROMSOE	UNST	6.96057	23.5856	16.625
TROMSOE	UNST	6.96057	20.5856	13.625
TROMSOE	UNST	7.04919	39.6313	32.5821
VARDOE	UNST	7.17225	32.7309	25.5586

Victim GS Name	Interfering GS Name	C/I Margin (dB)	C/I (dB)	Required C/I (dB)
VARDOE	UNST	11.107	31.0342	19.9272
VARDOE	UNST	11.107	28.0342	16.9272
ANDOYA	UNST	12.248	28.0802	15.8323
ANDOYA	UNST	12.248	28.0802	15.8323
TROMSOE	UNST	12.3743	29.0362	16.6619
TROMSOE	UNST	12.3743	29.0362	16.6619
SVALBARD	UNST	12.3743	29.0362	16.6619
VARDOE	UNST	16.4368	36.4009	19.9641
VARDOE	UNST	16.4368	36.4009	19.9641
SVALBARD	UNST	19.0319	29.7529	10.721
SVALBARD	UNST	19.0322	32.753	13.7208
SVALBARD	UNST	24.7849	38.5427	13.7577

TABLE 2 C/I metrics

Victim GS Name	Interfering GS Name	Carrier Signal (dB)	Interfering Signal (dB)
AWARUA	AWARUR	-108.386	-111.85
AWARUA	AWARUR	-121.11	-122.109
AWARUA	AWARUR	-124.11	-122.109
AWARUA	AWARUR	-116.01	-122.787
AWARUA	AWARUR	-116.01	-122.787
ANDOYA	UNST	-101.847	-133.678
SVALBARD	UNST	-104.555	-140.398
ANDOYA	UNST	-117.181	-139.896
ANDOYA	UNST	-120.181	-139.896
TROMSOE	UNST	-116.351	-139.937
TROMSOE	UNST	-119.351	-139.937
TROMSOE	UNST	-101.651	-141.282
VARDOE	UNST	-108.675	-141.406
VARDOE	UNST	-113.049	-144.083
VARDOE	UNST	-116.049	-144.083
ANDOYA	UNST	-112.081	-140.161
ANDOYA	UNST	-112.081	-140.161
TROMSOE	UNST	-111.251	-140.287
TROMSOE	UNST	-111.251	-140.287
SVALBARD	UNST	-111.251	-140.287
VARDOE	UNST	-107.949	-144.35
VARDOE	UNST	-107.949	-144.35
SVALBARD	UNST	-122.255	-152.008
SVALBARD	UNST	-119.255	-152.008
SVALBARD	UNST	-114.155	-152.698

TABLE 3 Signal intensities

2.2 Uplink worst-case passes

Victim GS Name	Interfering GS Name	Longest Violation (s)	Longest Daily Total (s)
ANDOYA	UNST	10	10
SVALBARD	BLONDUOS	1	1
AWARUA	AWARUA	24	24
TROMSOE	UNST	6	6
VARDOE	UNST	2	2
ANDOYA	UNST	10	10
VARDOE	UNST	2	2
AWARUA	AWARUA	24	24
TROMSOE	UNST	6	6
SVALBARD	BLONDUOS	1	1
ANDOYA	UNST	11	11
TROMSOE	UNST	9	9
AWARUA	AWARUA	25	25
SVALBARD	BLONDUOS	1	1
VARDOE	UNST	2	2
AWARUA	AWARUA	19	19
AWARUA	AWARUA	19	19

TABLE 4 Below-margin time per victim ground station

Victim GS Name	Interfering GS Name	C/I Margin (dB)	C/I (dB)	Required C/I (dB)
AWARUA	AWARUA	-16.0304	-6.55707	9.4733
AWARUA	AWARUA	-14.7732	-21.2571	-6.48384
AWARUA	AWARUA	-14.7732	-24.2571	-9.48384
AWARUA	AWARUA	-9.71014	-16.1571	-6.44693
AWARUA	AWARUA	-9.71014	-16.1571	-6.44693
ANDOYA	UNST	-6.10526	7.28659	13.3919
ANDOYA	UNST	-4.84812	-7.4134	-2.56528
ANDOYA	UNST	-4.84812	-10.4134	-5.56528
TROMSOE	UNST	-4.61945	9.60286	14.2223
TROMSOE	UNST	-3.36231	-5.09714	-1.73482
TROMSOE	UNST	-3.36231	-8.09714	-4.73482
SVALBARD	BLONDUOS	-2.4093	7.42597	9.83527
VARDOE	UNST	-2.22145	5.93648	8.15794
SVALBARD	BLONDUOS	-1.15216	-7.27411	-6.12195
SVALBARD	BLONDUOS	-1.15216	-10.274	-9.12186
VARDOE	UNST	-0.964318	-8.76351	-7.79919
VARDOE	UNST	-0.964318	-11.7635	-10.7992
ANDOYA	UNST	0.214975	-2.31341	-2.52838
ANDOYA	UNST	0.214975	-2.31341	-2.52838
TROMSOE	UNST	1.70078	0.00286278	-1.69792

Victim GS Name	Interfering GS Name	C/I Margin (dB)	C/I (dB)	Required C/I (dB)
TROMSOE	UNST	1.70078	0.00286278	-1.69792
SVALBARD	UNST	1.70078	0.00286278	-1.69792
SVALBARD	BLONDUOS	3.91094	-2.17411	-6.08504
VARDOE	UNST	4.09878	-3.66351	-7.76229
VARDOE	UNST	4.09878	-3.66351	-7.76229

TABLE 5 C/I metrics

Victim GS Name	Interfering GS Name	Carrier Signal (dB)	Interfering Signal (dB)
AWARUA	AWARUA	-112.582	-106.025
AWARUA	AWARUA	-127.282	-106.025
AWARUA	AWARUA	-130.282	-106.025
AWARUA	AWARUA	-122.182	-106.025
AWARUA	AWARUA	-122.182	-106.025
ANDOYA	UNST	-108.663	-115.95
ANDOYA	UNST	-123.363	-115.95
ANDOYA	UNST	-126.363	-115.95
TROMSOE	UNST	-107.833	-117.436
TROMSOE	UNST	-122.533	-117.436
TROMSOE	UNST	-125.533	-117.436
SVALBARD	BLONDUOS	-112.22	-119.646
VARDOE	UNST	-113.897	-119.834
SVALBARD	BLONDUOS	-126.92	-119.646
SVALBARD	BLONDUOS	-129.92	-119.646
VARDOE	UNST	-128.597	-119.834
VARDOE	UNST	-131.597	-119.834
ANDOYA	UNST	-118.263	-115.95
ANDOYA	UNST	-118.263	-115.95
TROMSOE	UNST	-117.433	-117.436
TROMSOE	UNST	-117.433	-117.436
SVALBARD	UNST	-117.433	-117.436
SVALBARD	BLONDUOS	-121.82	-119.646
VARDOE	UNST	-123.497	-119.834
VARDOE	UNST	-123.497	-119.834

TABLE 6 Signal intensities

3 Critical interference snapshots

This section shows the Earth globe at each critical event's worst-case instant, centered at the selected victim ground station, together with the interference link lines.

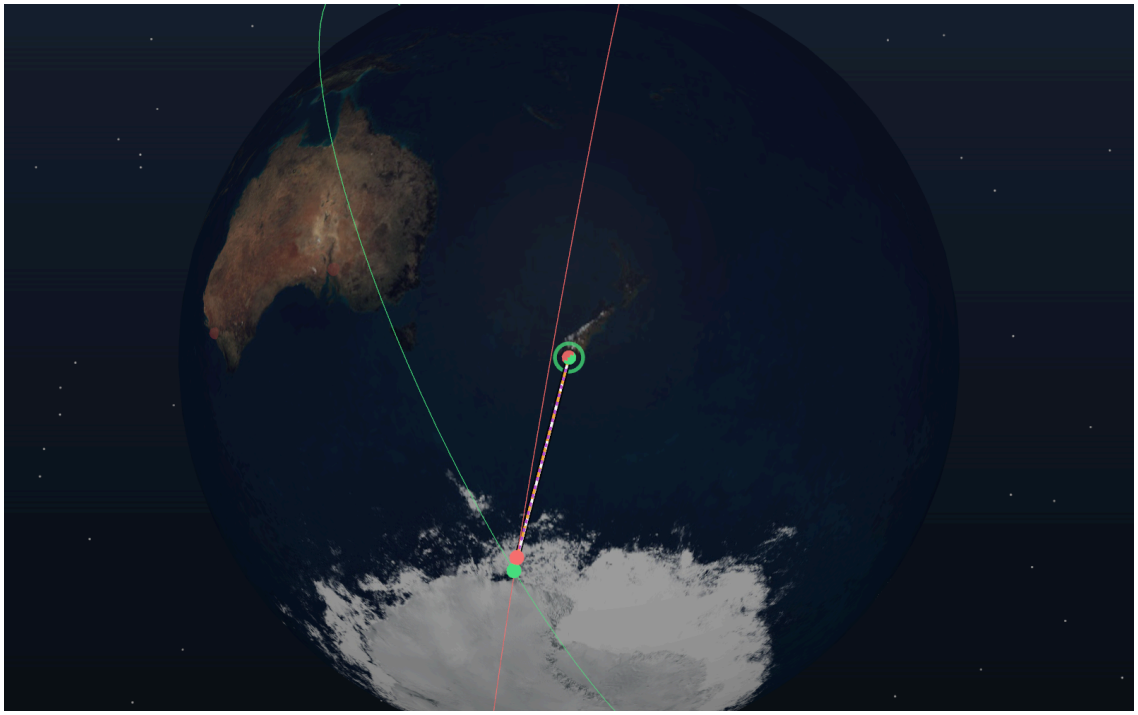

FIGURE 1 downlink · AWARUA ↔ AWARUR · margin -22.4 dB · 2027-02-01 01:08:51 UTC

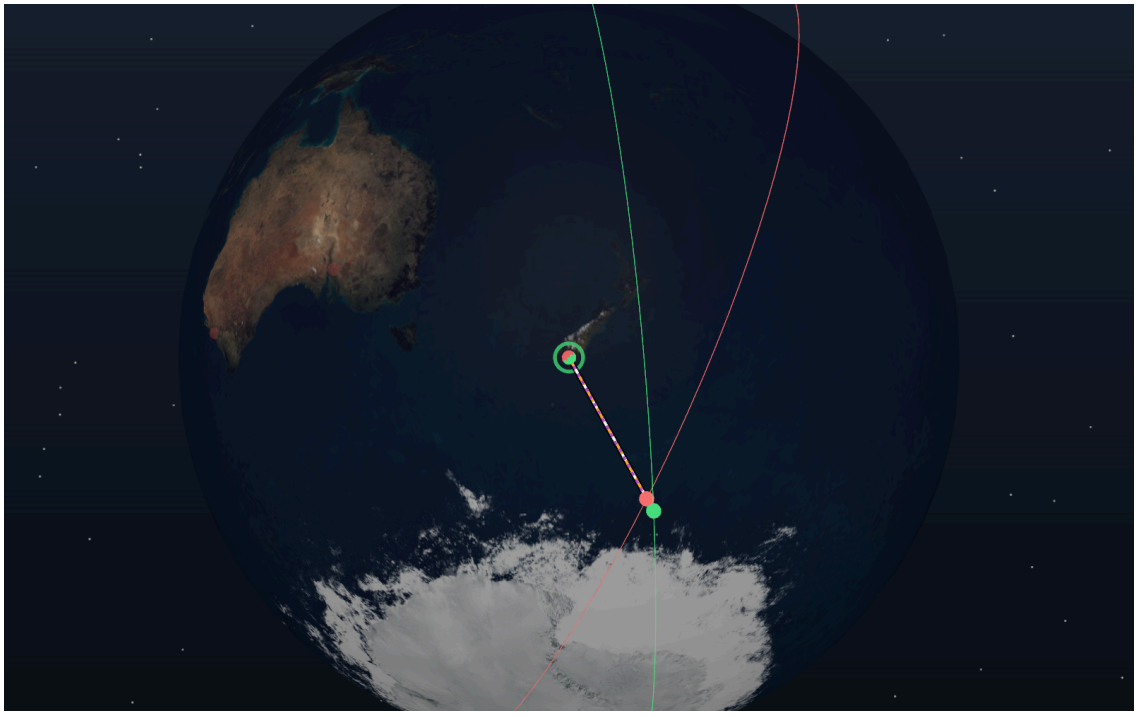

FIGURE 2 uplink · AWARUA ↔ AWARUA · margin -16.0 dB · 2026-08-21 23:14:52 UTC

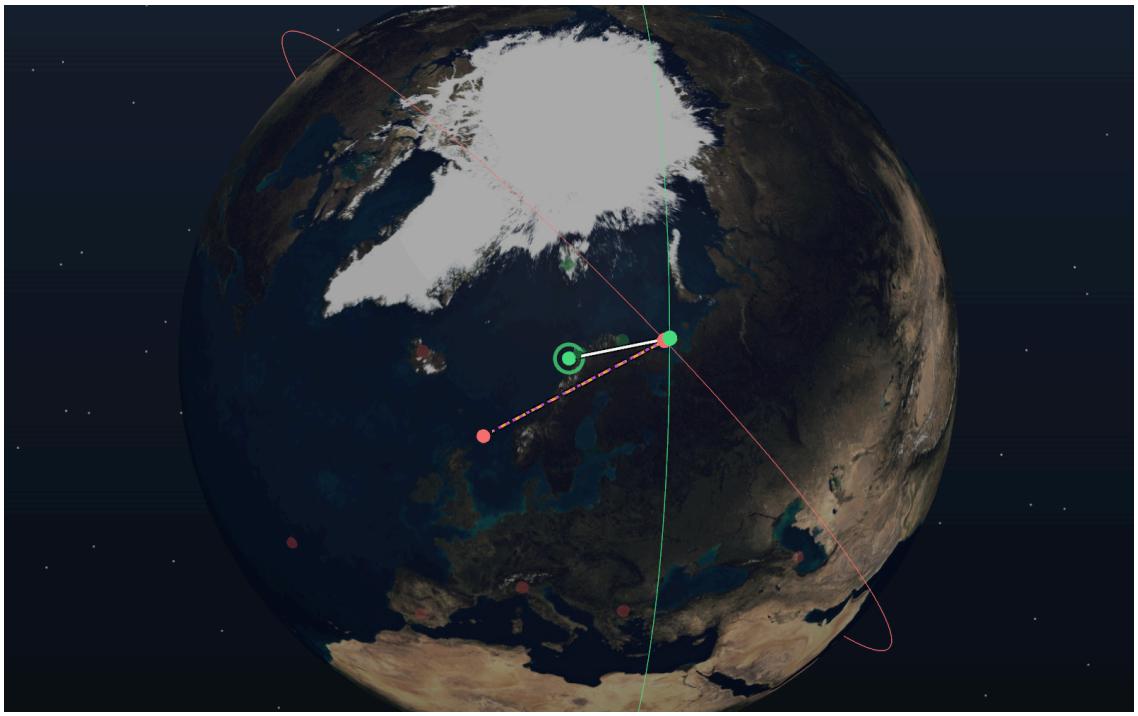

FIGURE 3 uplink · ANDOYA ↔ UNST · margin -6.1 dB · 2027-07-02 21:22:25 UTC

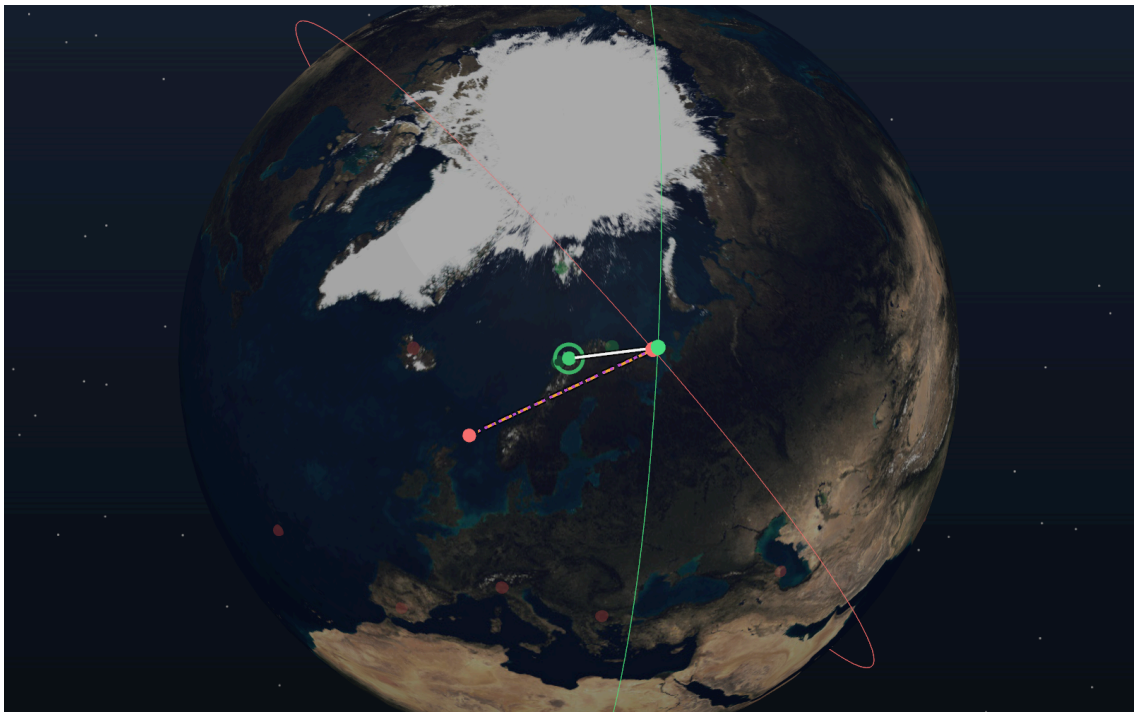

FIGURE 4 uplink · TROMSOE ↔ UNST · margin -4.6 dB · 2027-07-02 21:22:25 UTC

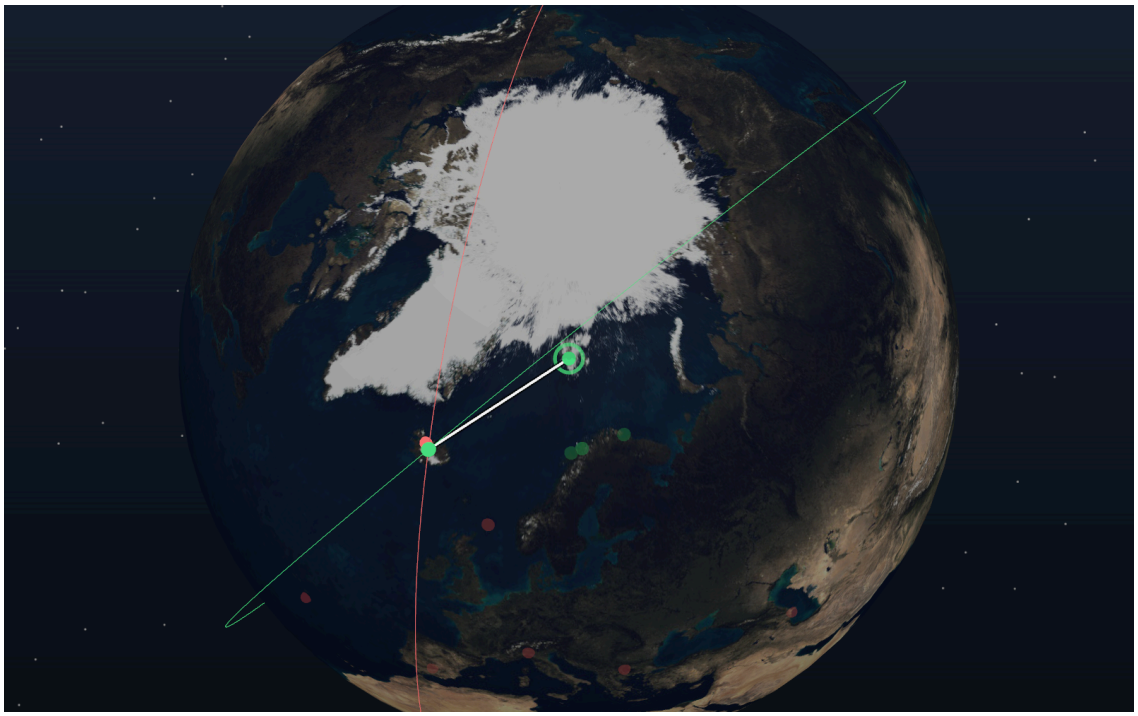

FIGURE 5 uplink · SVALBARD ↔ BLONDUOS · margin -2.4 dB · 2027-05-02 00:57:22 UTC

FIGURE 6 uplink · VARDOE ↔ UNST · margin -2.2 dB · 2027-03-18 00:39:07 UTC

4 Simulation configuration

4.1 Satellite networks

Note that this report operates on data consolidated across the entire IFIC corpus. This means that the IFIC listed for each notice refers to the most recent version of the data across the corpus.

Name	Notice ID	IFIC	Date of receipt	Administration
RATATOSK-1A	124545174	IFIC 3043	2024-06-04	NOR

TABLE 7 Victim satellite network and associated ITU notice IDs

Name	Notice ID	IFIC	Date of receipt	Administration
HSD	124545183	IFIC 3043	2024-06-17	GRC

TABLE 8 Interfering satellite network and associated ITU notice IDs

4.2 Frequency band overlap

Frequency overlap is the precondition for interference: the analysis only evaluates a victim and an interfering beam against each other when they point the same direction and share a frequency band.

Victim beam	Victim band (MHz)	Interfering beam	Interf band (MHz)	Shared (MHz)
SDR2	650–6000	SISLE	2242.5–2247.5	2242.5–2247.5 (5)
SDR2	650–6000	SBNDDL	2252.5–2257.5	2252.5–2257.5 (5)
XD	8026–8350	XBNDDL	8215–8235	8215–8235 (20)

TABLE 9 Overlapping downlink (emitting) frequency pairs

Victim beam	Victim band (MHz)	Interfering beam	Interf band (MHz)	Shared (MHz)
SDR2	650–6000	SBNDUL	2067.5–2072.5	2067.5–2072.5 (5)
SDR2	650–6000	SISLR	2242.5–2247.5	2242.5–2247.5 (5)

TABLE 10 Overlapping uplink (receiving) frequency pairs

4.3 Satellite beam characteristics

Name	Min Frequency (MHz)	Max Frequency (MHz)	Gain (dBi)	ITU Pattern ID	Kind
SDR2	650	6000	3	610	R
SDR1	50	650	0	610	R
LRTTCU	2102	2108	-5	610	R
HRTTCU	2102	2108	-5	610	R
XD	8026	8350	17	609	E
SDR2	650	6000	3	609	E
SDR1	50	650	0	609	E
LRTTCD	2283	2287	4	609	E
HRTTCD	2282	2288	7	609	E

TABLE 11 Antenna beams associated with the victim satellite network

Name	Min Frequency (MHz)	Max Frequency (MHz)	Gain (dBi)	ITU Pattern ID	Kind
SISLR	2242.5	2247.5	7	0	R
SBNDUL	2067.5	2072.5	6	0	R
XBNDDL	8215	8235	15.5	0	E
SISLE	2242.5	2247.5	7	0	E
SBNDDL	2252.5	2257.5	6	0	E

TABLE 12 Antenna beams associated with the interfering satellite network

4.4 Ground station characteristics

4.4.1 Victim ground stations

Name	Group ID	Latitude (deg)	Longitude (deg)
ANDOYA	124687334	69.2786	16.0081
SVALBARD	124687334	78.2317	15.4111
TROLL	124687334	-72.0028	2.525
AWARUA	124687334	-46.5289	168.38
HARTEBEESTHOEK	124687334	-25.8861	27.7056
TROMSOE	124687334	69.6633	18.9494
VARDOE	124687334	70.3369	31.0311
ANDOYA	124687335	69.2786	16.0081
VARDOE	124687335	70.3369	31.0311
TROLL	124687335	-72.0028	2.525
AWARUA	124687335	-46.5289	168.38
HARTEBEESTHOEK	124687335	-25.8861	27.7056
TROMSOE	124687335	69.6633	18.9494
SVALBARD	124687335	78.2314	15.4111
ANDOYA	124687349	69.2786	16.0081
TROMSOE	124687349	69.6633	18.9494
TROLL	124687349	-72.0028	2.525
AWARUA	124687349	-46.5289	168.38
HARTEBEESTHOEK	124687349	-25.8861	27.7056
SVALBARD	124687349	78.2314	15.4111
VARDOE	124687349	70.3369	31.0311
ANDOYA	124687350	69.2786	16.0081
VARDOE	124687350	70.3369	31.0311
TROLL	124687350	-72.0028	2.525
AWARUA	124687350	-46.5289	168.38
HARTEBEESTHOEK	124687350	-25.8861	27.7056
SVALBARD	124687350	78.2317	15.4111
TROMSOE	124687350	69.6633	18.9494
ANDOYA	124687351	69.2786	16.0081
VARDOE	124687351	70.3369	31.0311
TROLL	124687351	-72.0028	2.525
AWARUA	124687351	-46.5289	168.38
HARTEBEESTHOEK	124687351	-25.8861	27.7056
TROMSOE	124687351	69.6633	18.9494
SVALBARD	124687351	69.6633	18.9494

TABLE 13 Coordinates of the specific victim ground stations

Name	Group ID	Altitude (deg)	Min Elevation (deg)
ANDOYA	124687334	0	5

Name	Group ID	Altitude (deg)	Min Elevation (deg)
SVALBARD	124687334	0	5
TROLL	124687334	0	5
AWARUA	124687334	0	5
HARTEBEESTHOEK	124687334	0	5
TROMSOE	124687334	0	5
VARDOE	124687334	0	5
ANDOYA	124687335	0	5
VARDOE	124687335	0	5
TROLL	124687335	0	5
AWARUA	124687335	0	5
HARTEBEESTHOEK	124687335	0	5
TROMSOE	124687335	0	5
SVALBARD	124687335	0	5
ANDOYA	124687349	0	5
TROMSOE	124687349	0	5
TROLL	124687349	0	5
AWARUA	124687349	0	5
HARTEBEESTHOEK	124687349	0	5
SVALBARD	124687349	0	5
VARDOE	124687349	0	5
ANDOYA	124687350	0	5
VARDOE	124687350	0	5
TROLL	124687350	0	5
AWARUA	124687350	0	5
HARTEBEESTHOEK	124687350	0	5
SVALBARD	124687350	0	5
TROMSOE	124687350	0	5
ANDOYA	124687351	0	5
VARDOE	124687351	0	5
TROLL	124687351	0	5
AWARUA	124687351	0	5
HARTEBEESTHOEK	124687351	0	5
TROMSOE	124687351	0	5
SVALBARD	124687351	0	5

TABLE 14 Geometric characteristics of the specific victim ground stations

Name	Group ID	Envelope Power (dBW)	Gain (dBi)
ANDOYA	124687334	3	34.7
SVALBARD	124687334	3	34.7
TROLL	124687334	3	34.7
AWARUA	124687334	3	34.7
HARTEBEESTHOEK	124687334	3	34.7

Name	Group ID	Envelope Power (dBW)	Gain (dBi)
TROMSOE	124687334	3	34.7
VARDOE	124687334	3	34.7
ANDOYA	124687335	0	34.7
VARDOE	124687335	0	34.7
TROLL	124687335	0	34.7
AWARUA	124687335	0	34.7
HARTEBEESTHOEK	124687335	0	34.7
TROMSOE	124687335	0	34.7
SVALBARD	124687335	0	34.7
ANDOYA	124687349	4.8	47.6
TROMSOE	124687349	4.8	47.6
TROLL	124687349	4.8	47.6
AWARUA	124687349	4.8	47.6
HARTEBEESTHOEK	124687349	4.8	47.6
SVALBARD	124687349	4.8	47.6
VARDOE	124687349	4.8	47.6
ANDOYA	124687350	8.8	34
VARDOE	124687350	8.8	34
TROLL	124687350	8.8	34
AWARUA	124687350	8.8	34
HARTEBEESTHOEK	124687350	8.8	34
SVALBARD	124687350	8.8	34
TROMSOE	124687350	8.8	34
ANDOYA	124687351	8.8	34
VARDOE	124687351	8.8	34
TROLL	124687351	8.8	34
AWARUA	124687351	8.8	34
HARTEBEESTHOEK	124687351	8.8	34
TROMSOE	124687351	8.8	34
SVALBARD	124687351	8.8	34

TABLE 15 Antenna power and gain of the specific victim ground stations

Name	Group ID	Beamwidth (deg)	Noise Temperature (K)
ANDOYA	124687334	2.5	187
SVALBARD	124687334	2.5	187
TROLL	124687334	2.5	187
AWARUA	124687334	2.5	187
HARTEBEESTHOEK	124687334	2.5	187
TROMSOE	124687334	2.5	187
VARDOE	124687334	2.5	187
ANDOYA	124687335	2.5	187
VARDOE	124687335	2.5	187

Name	Group ID	Beamwidth (deg)	Noise Temperature (K)
TROLL	124687335	2.5	187
AWARUA	124687335	2.5	187
HARTEBEESTHOEK	124687335	2.5	187
TROMSOE	124687335	2.5	187
SVALBARD	124687335	2.5	187
ANDOYA	124687349	0.66	140
TROMSOE	124687349	0.66	140
TROLL	124687349	0.66	140
AWARUA	124687349	0.66	140
HARTEBEESTHOEK	124687349	0.66	140
SVALBARD	124687349	0.66	140
VARDOE	124687349	0.66	140
ANDOYA	124687350	2.71	600
VARDOE	124687350	2.71	600
TROLL	124687350	2.71	600
AWARUA	124687350	2.71	600
HARTEBEESTHOEK	124687350	2.71	600
SVALBARD	124687350	2.71	600
TROMSOE	124687350	2.71	600
ANDOYA	124687351	2.71	600
VARDOE	124687351	2.71	600
TROLL	124687351	2.71	600
AWARUA	124687351	2.71	600
HARTEBEESTHOEK	124687351	2.71	600
TROMSOE	124687351	2.71	600
SVALBARD	124687351	2.71	600

TABLE 16 Antenna beamwidth and noise temperature of the specific victim ground stations

Name	Group ID	Pattern Coefficient A	Pattern ID
ANDOYA	124687334	29	601
SVALBARD	124687334	29	601
TROLL	124687334	29	601
AWARUA	124687334	29	601
HARTEBEESTHOEK	124687334	29	601
TROMSOE	124687334	29	601
VARDOE	124687334	29	601
ANDOYA	124687335	29	601
VARDOE	124687335	29	601
TROLL	124687335	29	601
AWARUA	124687335	29	601
HARTEBEESTHOEK	124687335	29	601
TROMSOE	124687335	29	601

Name	Group ID	Pattern Coefficient A	Pattern ID
SVALBARD	124687335	29	601
ANDOYA	124687349	29	601
TROMSOE	124687349	29	601
TROLL	124687349	29	601
AWARUA	124687349	29	601
HARTEBEESTHOEK	124687349	29	601
SVALBARD	124687349	29	601
VARDOE	124687349	29	601
ANDOYA	124687350	29	602
VARDOE	124687350	29	602
TROLL	124687350	29	602
AWARUA	124687350	29	602
HARTEBEESTHOEK	124687350	29	602
SVALBARD	124687350	29	602
TROMSOE	124687350	29	602
ANDOYA	124687351	29	602
VARDOE	124687351	29	602
TROLL	124687351	29	602
AWARUA	124687351	29	602
HARTEBEESTHOEK	124687351	29	602
TROMSOE	124687351	29	602
SVALBARD	124687351	29	602

TABLE 17 Antenna pattern characteristics of the specific victim ground stations

Name	Group ID	Altitude (deg)	Min Elevation (deg)
UT1	124687387	0	5
UT1	124687386	0	5
UT1	124687347	0	5
UT1	124687346	0	5
UT1	124687345	0	5
UT1	124687344	0	5
UT1	124687343	0	5
UT1	124687342	0	5
UT1	124687341	0	5
UT1	124687340	0	5
UT1	124687339	0	5
UT1	124687338	0	5
UT1	124687337	0	5
UT1	124687336	0	5
UT1	124687384	0	5
UT1	124687383	0	5
UT1	124687382	0	5

Name	Group ID	Altitude (deg)	Min Elevation (deg)
UT1	124687381	0	5
UT1	124687380	0	5
UT1	124687379	0	5
UT1	124687378	0	5
UT1	124687377	0	5
UT1	124687353	0	5
UT1	124687352	0	5
UT1	124687348	0	5
UT1	124687385	0	5
UT1	124687364	0	5
UT1	124687363	0	5
UT1	124687362	0	5
UT1	124687361	0	5
UT1	124687360	0	5
UT1	124687359	0	5
UT1	124687358	0	5
UT1	124687357	0	5
UT1	124687356	0	5
UT1	124687355	0	5
UT1	124687354	0	5
UT1	124687376	0	5
UT1	124687375	0	5
UT1	124687374	0	5
UT1	124687373	0	5
UT1	124687372	0	5
UT1	124687371	0	5
UT1	124687370	0	5
UT1	124687369	0	5
UT1	124687368	0	5
UT1	124687367	0	5
UT1	124687366	0	5
UT1	124687365	0	5

TABLE 18 Geometric characteristics of the typical victim ground stations

Name	Group ID	Envelope Power (dBW)	Gain (dBi)
UT1	124687387	5	2
UT1	124687386	5	2
UT1	124687347	5	2
UT1	124687346	5	2
UT1	124687345	5	2
UT1	124687344	5	2
UT1	124687343	5	2

Name	Group ID	Envelope Power (dBW)	Gain (dBi)
UT1	124687342	5	2
UT1	124687341	5	2
UT1	124687340	5	2
UT1	124687339	5	2
UT1	124687338	5	2
UT1	124687337	5	2
UT1	124687336	5	2
UT1	124687384	5	2
UT1	124687383	5	2
UT1	124687382	5	2
UT1	124687381	5	2
UT1	124687380	5	2
UT1	124687379	5	2
UT1	124687378	5	2
UT1	124687377	5	2
UT1	124687353	5	2
UT1	124687352	5	2
UT1	124687348	5	2
UT1	124687385	5	2
UT1	124687364	5	2
UT1	124687363	5	2
UT1	124687362	5	2
UT1	124687361	5	2
UT1	124687360	5	2
UT1	124687359	5	2
UT1	124687358	5	2
UT1	124687357	5	2
UT1	124687356	5	2
UT1	124687355	5	2
UT1	124687354	5	2
UT1	124687376	5	2
UT1	124687375	5	2
UT1	124687374	5	2
UT1	124687373	5	2
UT1	124687372	5	2
UT1	124687371	5	2
UT1	124687370	5	2
UT1	124687369	5	2
UT1	124687368	5	2
UT1	124687367	5	2
UT1	124687366	5	2

Name	Group ID	Envelope Power (dBW)	Gain (dBi)
UT1	124687365	5	2

TABLE 19 Antenna power and gain of the typical victim ground stations

Name	Group ID	Beamwidth (deg)	Noise Temperature (K)
UT1	124687387	180	600
UT1	124687386	180	600
UT1	124687347	180	600
UT1	124687346	180	600
UT1	124687345	180	600
UT1	124687344	180	600
UT1	124687343	180	600
UT1	124687342	180	600
UT1	124687341	180	600
UT1	124687340	180	600
UT1	124687339	180	600
UT1	124687338	180	600
UT1	124687337	180	600
UT1	124687336	180	600
UT1	124687384	180	600
UT1	124687383	180	600
UT1	124687382	180	600
UT1	124687381	180	600
UT1	124687380	180	600
UT1	124687379	180	600
UT1	124687378	180	600
UT1	124687377	180	600
UT1	124687353	180	600
UT1	124687352	180	600
UT1	124687348	180	600
UT1	124687385	180	600
UT1	124687364	180	600
UT1	124687363	180	600
UT1	124687362	180	600
UT1	124687361	180	600
UT1	124687360	180	600
UT1	124687359	180	600
UT1	124687358	180	600
UT1	124687357	180	600
UT1	124687356	180	600
UT1	124687355	180	600
UT1	124687354	180	600
UT1	124687376	180	600

Name	Group ID	Beamwidth (deg)	Noise Temperature (K)
UT1	124687375	180	600
UT1	124687374	180	600
UT1	124687373	180	600
UT1	124687372	180	600
UT1	124687371	180	600
UT1	124687370	180	600
UT1	124687369	180	600
UT1	124687368	180	600
UT1	124687367	180	600
UT1	124687366	180	600
UT1	124687365	180	600

TABLE 20 Antenna beamwidth and noise temperature of the typical victim ground stations

Name	Group ID	Pattern Coefficient A	Pattern ID
UT1	124687387	29	607
UT1	124687386	29	607
UT1	124687347	29	607
UT1	124687346	29	607
UT1	124687345	29	607
UT1	124687344	29	607
UT1	124687343	29	607
UT1	124687342	29	607
UT1	124687341	29	607
UT1	124687340	29	607
UT1	124687339	29	607
UT1	124687338	29	607
UT1	124687337	29	607
UT1	124687336	29	607
UT1	124687384	29	607
UT1	124687383	29	607
UT1	124687382	29	607
UT1	124687381	29	607
UT1	124687380	29	607
UT1	124687379	29	607
UT1	124687378	29	607
UT1	124687377	29	607
UT1	124687353	29	607
UT1	124687352	29	607
UT1	124687348	29	607
UT1	124687385	29	608
UT1	124687364	29	608
UT1	124687363	29	608

Name	Group ID	Pattern Coefficient A	Pattern ID
UT1	124687362	29	608
UT1	124687361	29	608
UT1	124687360	29	608
UT1	124687359	29	608
UT1	124687358	29	608
UT1	124687357	29	608
UT1	124687356	29	608
UT1	124687355	29	608
UT1	124687354	29	608
UT1	124687376	29	608
UT1	124687375	29	608
UT1	124687374	29	608
UT1	124687373	29	608
UT1	124687372	29	608
UT1	124687371	29	608
UT1	124687370	29	608
UT1	124687369	29	608
UT1	124687368	29	608
UT1	124687367	29	608
UT1	124687366	29	608
UT1	124687365	29	608

TABLE 21 Antenna pattern characteristics of the typical victim ground stations

4.4.2 Interfering ground stations

Name	Group ID	Latitude (deg)	Longitude (deg)
VIMERCATE	124683599	45.5933	9.3622
UNST	124683599	60.7483	-0.8583
SANTAMARIA	124683599	36.9975	-25.1372
AWARUA	124683599	-46.5281	168.379
KANDY	124683599	7.2742	80.725
BLONDUOS	124683599	65.6475	-20.2461
ABSHERON	124683599	40.4664	49.4858
NANGETTY	124683599	-29.0106	115.342
PETERBOROUGH	124683599	-32.9619	138.849
PLANA	124683599	42.4831	23.4453
UNST	124683601	60.7483	-0.8583
SANTAMARIA	124683601	36.9975	-25.1372
AWARUR	124683601	-46.5281	168.379
KANDY	124683601	7.2742	80.725
BLONDUOS	124683601	65.6475	-20.2461
ABSHERON	124683601	40.4664	49.4858

Name	Group ID	Latitude (deg)	Longitude (deg)
NANGETTY	124683601	-29.0106	115.342
PETERBOROUGH	124683601	-32.9619	138.849
PLANA	124683601	42.4831	23.4453
VIMERCATE	124683600	45.5933	9.3622
PUERTOLLANO	124683600	38.6739	-4.1619
UNST	124683600	60.7483	-0.8583
SANTAMARIA	124683600	36.9975	-25.1372
AWARUA	124683600	-46.5281	168.379
KANDY	124683600	7.2742	80.725
BLONDUOS	124683600	65.6475	-20.2461
ABSHERON	124683600	40.4664	49.4858
NANGETTY	124683600	-29.0106	115.342
PETERBOROUGH	124683600	-32.9619	138.849
PLANA	124683600	42.4831	23.4453

TABLE 22 Coordinates of the specific interfering ground stations

Name	Group ID	Altitude (deg)	Min Elevation (deg)
VIMERCATE	124683599	0	5
UNST	124683599	0	5
SANTAMARIA	124683599	0	5
AWARUA	124683599	0	5
KANDY	124683599	0	5
BLONDUOS	124683599	0	5
ABSHERON	124683599	0	5
NANGETTY	124683599	0	5
PETERBOROUGH	124683599	0	5
PLANA	124683599	0	5
UNST	124683601	0	5
SANTAMARIA	124683601	0	5
AWARUR	124683601	0	5
KANDY	124683601	0	5
BLONDUOS	124683601	0	5
ABSHERON	124683601	0	5
NANGETTY	124683601	0	5
PETERBOROUGH	124683601	0	5
PLANA	124683601	0	5
VIMERCATE	124683600	0	5
PUERTOLLANO	124683600	0	5
UNST	124683600	0	5
SANTAMARIA	124683600	0	5
AWARUA	124683600	0	5
KANDY	124683600	0	5

Name	Group ID	Altitude (deg)	Min Elevation (deg)
BLONDUOS	124683600	0	5
ABSHERON	124683600	0	5
NANGETTY	124683600	0	5
PETERBOROUGH	124683600	0	5
PLANA	124683600	0	5

TABLE 23 Geometric characteristics of the specific interfering ground stations

Name	Group ID	Envelope Power (dBW)	Gain (dBi)
VIMERCATE	124683599	0	35
UNST	124683599	0	34.6
SANTAMARIA	124683599	0	34.6
AWARUA	124683599	0	34.6
KANDY	124683599	0	34.6
BLONDUOS	124683599	0	34.6
ABSHERON	124683599	0	34.6
NANGETTY	124683599	0	34.6
PETERBOROUGH	124683599	0	34.6
PLANA	124683599	0	35.8
UNST	124683601	3	47
SANTAMARIA	124683601	3	47
AWARUR	124683601	3	47
KANDY	124683601	3	47
BLONDUOS	124683601	3	47
ABSHERON	124683601	3	47
NANGETTY	124683601	3	47
PETERBOROUGH	124683601	3	47
PLANA	124683601	3	47
VIMERCATE	124683600	20	34.3
PUERTOLLANO	124683600	20	34.3
UNST	124683600	20	35
SANTAMARIA	124683600	20	35
AWARUA	124683600	20	35
KANDY	124683600	20	35
BLONDUOS	124683600	20	35
ABSHERON	124683600	20	35
NANGETTY	124683600	20	35
PETERBOROUGH	124683600	20	35
PLANA	124683600	20	35.8

TABLE 24 Antenna power and gain of the specific interfering ground stations

Name	Group ID	Beamwidth (deg)	Noise Temperature (K)
VIMERCATE	124683599	3.1	284

Name	Group ID	Beamwidth (deg)	Noise Temperature (K)
UNST	124683599	2.4	141
SANTAMARIA	124683599	2.4	141
AWARUA	124683599	2.4	141
KANDY	124683599	2.4	141
BLONDUOS	124683599	2.4	141
ABSHERON	124683599	2.4	141
NANGETTY	124683599	2.4	141
PETERBOROUGH	124683599	2.4	141
PLANA	124683599	2.2	135
UNST	124683601	0.6	128
SANTAMARIA	124683601	0.6	128
AWARUR	124683601	0.6	128
KANDY	124683601	0.6	128
BLONDUOS	124683601	0.6	128
ABSHERON	124683601	0.6	128
NANGETTY	124683601	0.6	128
PETERBOROUGH	124683601	0.6	128
PLANA	124683601	0.63	92
VIMERCATE	124683600	3.2	391
PUERTOLLANO	124683600	3.2	391
UNST	124683600	2.76	391
SANTAMARIA	124683600	2.76	391
AWARUA	124683600	2.76	391
KANDY	124683600	2.76	391
BLONDUOS	124683600	2.76	391
ABSHERON	124683600	2.76	391
NANGETTY	124683600	2.76	391
PETERBOROUGH	124683600	2.76	391
PLANA	124683600	2.2	391

TABLE 25 Antenna beamwidth and noise temperature of the specific interfering ground stations

Name	Group ID	Pattern Coefficient A	Pattern ID
VIMERCATE	124683599	29	601
UNST	124683599	29	601
SANTAMARIA	124683599	29	601
AWARUA	124683599	29	601
KANDY	124683599	29	601
BLONDUOS	124683599	29	601
ABSHERON	124683599	29	601
NANGETTY	124683599	29	601
PETERBOROUGH	124683599	29	601
PLANA	124683599	29	601

Name	Group ID	Pattern Coefficient A	Pattern ID
UNST	124683601	29	601
SANTAMARIA	124683601	29	601
AWARUR	124683601	29	601
KANDY	124683601	29	601
BLONDUOS	124683601	29	601
ABSHERON	124683601	29	601
NANGETTY	124683601	29	601
PETERBOROUGH	124683601	29	601
PLANA	124683601	29	601
VIMERCATE	124683600	29	602
PUERTOLLANO	124683600	29	602
UNST	124683600	29	602
SANTAMARIA	124683600	29	602
AWARUA	124683600	29	602
KANDY	124683600	29	602
BLONDUOS	124683600	29	602
ABSHERON	124683600	29	602
NANGETTY	124683600	29	602
PETERBOROUGH	124683600	29	602
PLANA	124683600	29	602

TABLE 26 Antenna pattern characteristics of the specific interfering ground stations

4.5 Orbital elements

Semi Major Axis (m)	Eccentricity	Inclination (deg)	LTAN (hrs)	Argument of Perigee (deg)	True Anomaly (deg)
6.9681e+06	0	97.79	10.5	0	0

TABLE 27 Orbital elements of the victim network satellites

Semi Major Axis (m)	Eccentricity	Inclination (deg)	LTAN (hrs)	Argument of Perigee (deg)	True Anomaly (deg)
6.9131e+06	0	98	0	0	360
6.9131e+06	0	98	0	0	180

TABLE 28 Orbital elements of the interfering network satellites

4.6 Simulation parameters

Initial epoch (UTC)	Initial epoch (JD)	Duration (days)	Timestep size (seconds)
2026-07-17 10:12:36	2461238.9254166665	365	1

TABLE 29 Simulation parameters used for this interference analysis

5 The Odes Team

Odes is a deeptech Aerospace startup developing tools to increase space mission success rates and reduce costs and time spent. All tools are flight-proven. The team is building an end-to-end platform targeting the

whole mission timeline, from early proposal drafts to in-orbit operations. Toward that goal, we blend the rigor and attention to detail of institutional space, with the new space mentality of rapid iteration. The crown jewel of the Odes technology is a high-fidelity, featureful and performant simulation stack. Odes is an EMTECH SPACE spinoff and currently a three-member team.

6 Methodology

6.1 In-house interference analysis software

The bulk of the interference analysis is carried out using in-house software by the Odes team. The software is considered to be Technology Readiness Level (TRL) 9, since it has been validated against multiple analysis results, and it has been independently validated by the Information Transmission Systems and Material Technology lab of the National Technical University of Athens, an advisory to the Greek Administration. Additionally, the tool has successfully been used for many in-orbit satellite networks.

6.2 Notice-related data

The analysis software downloads all available International Frequency Information Circular (IFIC) databases published by the ITU. All required simulation data, such as orbital elements, ground station coordinates, or antenna beam specifications, are extracted from the IFIC databases into a custom, consolidated database. This Extract, Transform, Load (ETL) process ensures that all data is consolidated in a manner that preserves the most up-to-date information for each datapoint. Additional care goes into populating the database entries with sensible default values in the case where there's missing data, and taking modification or suppression notices into account. When consolidating, for each given notice, the most recent data is pulled first. If identical to the newer data, data from older versions is omitted. The output database is frequently updated to include data from all recently published IFIC databases. The software also supports modifying the imported data, as well as working with user-supplied data, to allow for more precise analysis results.

6.3 Orbital mechanics

The orbital elements of all the satellites that are part of the victim and the interfering satellite network are propagated across time, using J2 propagators. The J2 propagators were selected as accurate enough for the purpose of the interference analysis, which is more about using the satellite orbital elements to compute various possible combinations of satellites and ground stations that are close to each other, across time, and less about making use of precise information regarding spacecraft state. The initial epoch, as well as the simulation duration and timestep size are all configurable through the tool. The configuration for the current analysis can be found in Section 4. The entirety of the simulation code, from the propagator code as well as all coordinate transformations, etc. is flight-proven and tested against industry-standard implementations.

This approach works well for specific associated ground stations. For typical ground stations, it is slightly modified, since these entities are not bound to a particular place on the globe. For typical ground stations, the analysis co-locates the stations of the interfering satellite network on the corresponding stations of the victim satellite network, and treats them as always-transmitting. Typical associated ground stations of the victim satellite network are excluded from the analysis.

6.4 Interference analysis

6.4.1 Input data

The simulation receives as input the satellites in both networks, together with their linked ground stations and all of the antenna beam characteristics. Let's briefly introduce some terminology: we will refer to the satellites that are part of the victim satellite network as "victim satellites". Similarly, we'll refer to the satellites that are part of the interfering satellite network as "interfering satellites". In a similar fashion, we'll

refer to the ground stations linked to the victim satellites as “victim ground stations”, and to the ground stations linked to the interfering satellites as “interfering ground stations”. Lastly, we’ll refer to the antenna beams of either victim satellites or victim ground stations as “victim beams”, and to the beams of either interfering satellites or interfering ground stations as “interfering beams”.

6.4.2 Orbital mechanics

During each simulation timestep, all satellites are propagated using J2 propagators. Then, we identify all victim satellite <-> victim ground station pairs where each satellite is visible from the corresponding ground station. For each pair, we identify all of the interfering satellites that are visible from each ground station of each pair. Finally, for each group of three, we identify all of the interfering ground stations where the selected interfering satellites of the group are visible from. This process essentially identifies all 2-satellite, 2-ground station sets, consisting of a victim satellite and its linked ground station, and an interfering satellite and its linked ground station. The victim satellite is visible from the victim ground station. The interfering satellite is visible from the victim ground station, and also from the interfering ground station. This is based on two key assumptions. First, that each satellite is pointing to its linked ground station. Pointing accuracy is currently not taken into account – we assume perfect pointing. Second, that if a satellite is not visible from any of its associated ground stations, it is not transmitting any data.

After computing all the different visible satellite-ground station groups across the total simulation duration, we investigate all of the associated antenna beams of the group. To assess whether there is potential interference in space-to-earth (downlink) and earth-to-space (uplink) links, we first check for frequency overlap between the victim and interfering beams of matching types: either both emitting or both receiving, for downlink and uplink respectively. At this stage of the analysis we’ve identified cases of potential interference.

6.4.3 Carrier to Interference ratio

To assess the significance of the potential interference, we calculate the C/I. Specifically, the analysis identifies potential interference cases when the calculated C/I margin is negative:

$$\text{margin} = \text{C/I}_{\text{adjusted}} - \text{C/I}_{\text{required}}$$

The required C/I can be derived from the C/N based on the carrier type. C/N is the ratio of carrier to total noise power, which includes all internal system noise and interference from other systems. To calculate the C/N in the uplink case, we derive:

$$C/N_{\text{up}} = P_{\text{Tx ES Max}} + G_{\text{Tx ES Max}} + G(\theta)_{\text{Rx Sat}} - FSPL_{(\uparrow \text{Freq})} - \left(k + T_{\text{Sat}} + B_{(\uparrow \text{Emiss})}\right)$$

Where

$$C/N_{\text{up}} = P_{\text{Tx ES Max}} + G_{\text{Tx ES Max}} + G(\theta)_{\text{Rx Sat}} - FSPL_{(\uparrow \text{Freq})}$$

stands for the carrier power C, and

$$-\left(k + T_{\text{Sat}} + B_{(\uparrow \text{Emiss})}\right)$$

stands for the noise power, N.

To calculate the C/N in the downlink case, we derive, similarly:

$$C/N_{\text{down}} = P_{\text{Sat Max}} + G(\theta)_{\text{Tx Sat}} + G_{\text{Rx ES Max}} - FSPL_{(\downarrow \text{Freq})} - \left(k + T_{\text{ES}} + B_{(\uparrow \text{Emiss})}\right)$$

The adjusted C/I can be derived from the basic calculated C/I, $C/I_b(\text{dB})$, by subtracting the interference adjustment factor:

$$C/I = C/I_b - I_a$$

To calculate the C/I, we define the following:

Carrier power:

$$C_L(\text{dBW}) = P_r + G_r + G_R - FSPL$$

Noise power:

$$N(\text{dB}) = T + BW + k$$

Interference power:

$$I(\text{dBW}) = P + G_R + G_r - FSPL$$

Then, to calculate the C/I in the uplink case:

$$C\uparrow \ = P_{\text{Tx ES Max}} + G_{\text{Tx ES Max}} + G(\theta)_{\text{Rx Sat}} - FSPL_{(\uparrow \text{Freq})} \ (\text{dBW})$$

$$I\uparrow \ = P'_{\text{ES Max}} + G'(\varphi)_{\text{Tx ES}} + G(\theta')_{\text{Rx Sat}} - FSPL'_{(\uparrow \text{Freq})} \ (\text{dBW})$$

$$C/I\uparrow \ = C\uparrow - I\uparrow \ (\text{dB})$$

and, similarly, for the downlink:

$$C\downarrow \ = P_{\text{Sat Max}} + G(\theta)_{\text{Tx Sat}} + G_{\text{Rx ES Max}} - FSPL_{(\downarrow \text{Freq})} \ (\text{dBW})$$

$$I\downarrow \ = P'_{\text{Sat Max}} + G'(\varphi)_{\text{Tx Sat}} + G(\theta')_{\text{Rx ES}} - FSPL'_{(\downarrow \text{Freq})} \ (\text{dBW})$$

$$C/I\downarrow \ = C\downarrow - I\downarrow \ (\text{dB})$$

Gain calculations involve the antenna pattern, which means there are three distinct cases:

1. Gain calculations using an ITU pattern ID
2. Gain calculations using a user-supplied antenna pattern
3. Gain calculations without antenna pattern information

7 Acronyms

C/I – **Carrier to Interference ratio**: Carrier signal intensity over interfering signal intensity 3, 3, 3, 3, 3, 26, 26, 26, 26, 26, 26, 27, 27

ETL – **Extract, Transform, Load**: A three-phase computing process where data is extracted from an input source, transformed (including cleaning), and loaded into an output data container 25

IFIC – **International Frequency Information Circular**: A service publication published every two weeks by the Radiocommunication Bureau of the International Telecommunications Union 25, 25, 25

ITU – **International Telecommunications Union** 3, 25, 27

J2: An analytical orbit propagator that considers the J2 perturbation term of the geopotential field 25, 25, 26

TRL – **Technology Readiness Level**: A method for estimating the maturity of technologies developed at NASA 25

8 Contact Details

For further inquiries and engineering support, feel free to reach out to:

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