Dear Mr. Le,

Thank you for your questions regarding Kuiper Systems LLC's ("Kuiper") experimental STA request, ELS File No. 0469-EX-ST-2024, Call Sign WW9XYW. Below, please find additional explanatory materials and responses to each of your questions.

The instant STA request is an addition to the existing KuiperSat experimental license, Call Sign WM2XKY.

The purpose of this new experiment is to conduct transponder IOT measurements, not gateway communications operations. This IOT experiment uses different earth station antennas, a different location, and different emission designators. *See* Tables 1 and 2 below.

With regard to the space stations, KuiperSat-1 and -2, two changes are requested in the instant STA application:

- Point the downlink beam center at a new IOT earth station located in Los Angeles, California;
- Transmit two new signals - a wider band (500MHz vs 480MHz) test signal and a CW alignment signal.

All other aspects of the space station remain the same as in the existing license with the call sign WM2XKY (file number 0108-EX-CM-2023).

Table 1. Stations and Equipment

	IOT Earth Station	**Prototype Satellite**
Station type	FIXED	MOBILE[1]
Location	8500 Balboa Blvd, Northridge, Los Angeles, California. CA 91329. Los Angeles County. Latitude: 34° 13' 30.6" North Longitude: 118° 30' 0.5" West Height above the ground 10 m. Height above the building roof 3 m	Circular low-earth orbit Nominal altitude: 500km Orbit inclination: 30°
Equipment (qty) all co-located	- Cobham 1.3 m parabolic antenna (2), and - Cobham 2.4m Tactical Tracker antenna (1)	Amazon prototype satellite (2)

Table 2. Carrier Signal (Emission) Characteristics

	IOT Earth Station	**Prototype Satellite**
EIRP/ERP dBW (kW)	59/56.9 (794/489)	36/33.8 (3.9/2.398)
Input power to antenna (W)	1.3 m parabolic: 8.51 2.4m Tactical Tracker: 2.57	1.26
Frequency bands (GHz)	29.5-30.0	19.6-20.1
Emission designators	50M0G7W to 500MG7W 1H00NON	50M0G7W to 500MG7W 1H00NON
Modulation types	Phase modulation (QPSK/PSK)	

[1] Currently operational under ELS Call Sign WM2XKY.

	Amplitude and phase modulation (APSK) Continuous wave (CW)	
Frequency tolerance	<+/-10ppm	<+/-10ppm
Gain and 3 dB beam-widths (H/V)	1.3m antenna: 49.7 dBi @29.5GHz 0.6° /0.6° circular beam 2.4m antenna: 54.9 dBi @29.5GHz 0.3° /0.3° circular beam	35dBi @ 19.8GHz 2.8° /2.8° circular spot beam
Beam pointing direction	Uplink beam centered on either prototype satellite[2] Az =114-245° El =20-43°	Downlink spot beam centered on IOT earth station[3]

Answers to OET Questions

OET Question 1. The following information is needed: (1) KuiperSat-1 and KuiperSat-2 Ka-band NGSO prototype satellites only authorized to transmit emission 480MD7W to a 2.4m Cobham Tracker 2400 gateway antenna. Also, the 2.4m Cobham Tracker 2400 gateway antenna only authorized to transmit emission 480MD7W to KuiperSat-1 and KuiperSat-2 Ka-band NGSO satellites (see Narrative of 0956-EX-CN-2021). In "Station Location" of APPLICATION FOR SPECIAL TEMPORARY AUTHORITY, please amend the emission from 500MD7W to 480MD7W and the following technical parameters: Operations of a 2.4m Cobham Tracker 2400 gateway antenna must maintain within the following technical parameters: Frequency band Emission Gain power ERP Maximum EIRP 29.5-30 GHz 480MD7W 53.1dBi@30.0 GHz 3.89W 489778.819W 59dBW

Kuiper Answer: Please refer to the explanation above.

OET Question 2. In "Station Location" of APPLICATION FOR SPECIAL TEMPORARY AUTHORITY, please include 1.26W power in the 19.6-20.1 GHz band: Frequency band Emission Gain power ERP Maximum EIRP 19.6-20.1 GHz 480MD7W 35dBi @19.8GHz 1.26W 2398.833W 36dBW

Kuiper Answer: Please see Table 2 for the requested input power to the downlink satellite antenna, 1.26W.

OET Question 3. KuiperSat-1 and KuiperSat-2 Ka-band NGSO prototype satellites don't have authority to communicate with (2) Cobham 1.3 m parabolic antennas (see 0956-EX-CN-2021). Please remove the (2) Cobham 1.3 m parabolic antennas from APPLICATION FOR SPECIAL TEMPORARY AUTHORITY.

[2] Due to the earth station location, satellite altitude and inclination, the transmit beam is always pointing away from the GSO arc such that the experiment complies with Radio Regulations Article 22 EPFD↑ limits.

[3] Due to the satellite beam pointing there is always sufficient angular separation with GSO earth stations such that the experiment complies with Radio Regulations Article 22 EPFD↓ limits.

Kuiper Answer: Through the instant STA, Kuiper seeks to allow KuiperSat-1 and KuiperSat-2 to communicate with the Cobham 1.3 m parabolic and 2.4 m Cobham "Tactical Tracker" antennas.

OET Question 4. Please provide "INTERFERENCE PROTECTION FOR CO-FREQUENCY NGSO SYSTEMS" for 2.4m Cobham Tracker 2400 gateway antenna located at Los Angeles, LOS ANGELES,CA- NL 34-13-30; WL 118-30-01. (see APPENDIX 4, Narrative of 0956-EX-CN-2021)

Kuiper Answer: Table 3 below shows the results of searching the ICFS database for co-frequency (19.6-20.1 GHz) licensed earth stations within a 500 km radius: just one NGSO earth station licensed to Kuiper Systems LLC, which is non-operational, was found. Thus, we conclude that there are no interference cases to co-frequency NGSO earth stations from the requested downlink beam operations.

And as shown below in response to Question 5, Kuiper completed an EPFD↓ showing to confirm that the Kuiper downlink beam operations fully comply with Article 22 EPFD↓ Table 22-C limits that protect GSO earth stations.

Table 3. Co-frequency 19.6-20.1 GHz Earth Stations within 500km from the experiment location

1	2	3	4	5	6	7
Earth Station	**Licensee**	**Distance (km)**	**Latitude (North)**	**Longitude (West)**	**approx. off-axis gain (dB)**	**Station Type**
Experimental	pending STA grant	0.0	34:13'30.60"	118:30'0.5"	0	NGSO
Victim Earth Stations (call sign)						
GSO ref victim	Hypothetical reference	0.0	34:13'30.60"	118:30'0.5"	0	GSO
E160062	DIRECTV	28.0	33:58'58"	118:25'33"	-20	GSO
E050229	DIRECTV	28.0	33:58'58"	118:25'32"	3 to 6dB	GSO
E090025	DIRECTV	28.0	33:58'57.6"	160:11'12"	3 to 6dB	GSO
E050113	DIRECTV	28.1	33:58'57"	118:25'31.2"	3 to 6dB	GSO
E050121	DIRECTV	28.1	33:58'57"	118:25'31.2"	3 to 6dB	GSO
E060383	HNS	41.6	34:24'16.3"	118:53'38.3"	-15	GSO
E160022	SES Americom	47.2	34:19'31.9"	118:59'41.4"	-20	GSO
E040303	SES Americom	47.2	34:49'44.3"	118:12'42.35"	>-20	GSO
E070123	Open Plaza	51.8	33:49':44.3"	118"12':43.35"	> -20	GSO
E090024	DIRECTV	51.8	33:49":44.3	118:12':42.9	> -20	GSO
E202145	Safran Passenger Innovations	69.4	33:18':35.0"	117:51'18.2"	> -20	GSO
E150138	DIRECTV	132.6	35:47':43.5'	117:5' 26.1"	> -25	GSO
E170039	INTELSAT	139.6	33:47'42.7"	117:5'22.5"	> -25	GSO
E040213	VIASAT	139.6	33:47'42.2"	117:5'20.4"	> -25	GSO
E120195	VIASAT	168.4	33:7':34.25"	117:16':7.15"	> -25	GSO
E160092	VIASAT	168.4	33:7'41.2"	117:16':1.75"	> -25	GSO
E150088	HNS	192.1	32:59'21.8"	117:4'22.0"	> -30	GSO
E160110	VIASAT	380.0	36:8'33.7"	115:4'38.1"	> -30	GSO
E070290	DBSD Corp	382.9	36:14':9.7"	115:7'3.4"	> -30	GSO
E150089	HNS	382.9	36:14':11.8"	115:7'4.7"	> -30	GSO
E230024	Kuiper Systems LLC	442.1	36:55':45.8"	114:58':3.9"	> -30	**NGSO**
E150087	HNS	471.9	37:21':54.5"	121"30':38.33"	> -30	GSO
E160114	VIASAT	477.4	37:43:16.58"	121:30':38.33	> -30	GSO
E040415	SES Americom	497.8	37:36':8.9'	122:3' 53.0"	> -30	GSO

OET Question 5. Please provide the angular separation from the satellite downlink spot beam with GSO earth stations

Kuiper Answer: In Figure 1, the yellow points show the possible azimuth and elevation arrival angles of the downlink satellite signal at the experimental earth station, when observed over many days of operation. The blue line similarly shows the range of azimuth and elevation arrival angles of signals arriving from a GSO satellite. The difference in these angles, (vector sum of δAz+δEl) are the separation angles that OET have requested in question 5.

The minimum separation angle of 2.4 degrees occurs very infrequently and lasts for a few seconds as the Kuiper beam passes the GSO victim beam when the elevation angles[4] are 20 degrees and the victim

[4] The experimental earth station and downlink beam do not operate below 20 degrees elevation.

GSO earth station is collocated. Most of the time there is a very large angular separation (yellow dots to blue line), and there is never an in-line event with the GSO arc (yellow dots crossing the blue line).

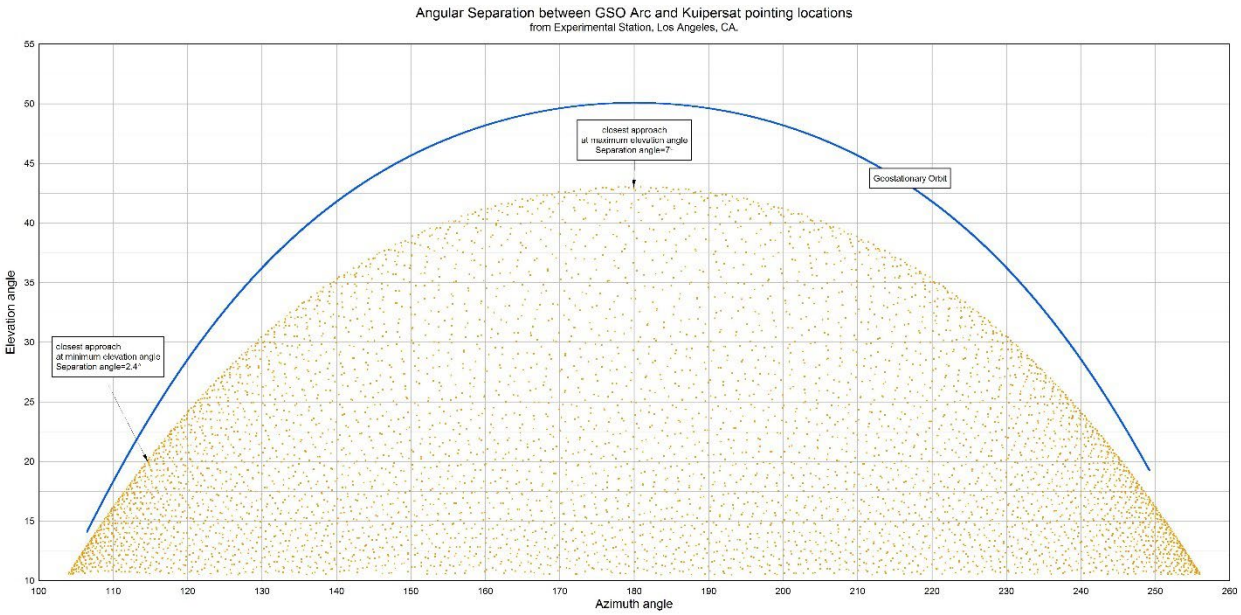


Figure 1 – Separation angles between GSO earth stations beams and Kuiper Downlink Beams

EPFD Down Calculation

Table 22-1C of Article 22 of the ITU Radio Regulations provides the downlink EPFD limits for a variety of reference GSO earth station sizes. The smallest of these reference GSO earth station antenna sizes, 70 cm, requires the largest angular separation. The never-to-exceed EPFD↓ level in Table 22-1C is -140 dBW/m^2/MHz.

Table 4 below shows the power-flux density (PFD) from the KuiperSat downlink at a variety of arrival angles (columns 1-3), and the minimum angular separation between the KuiperSat and the GSO arc for a reference GSO earth station co-located with the Kuiper earth station in Los Angeles, CA (column 4). Table 4 shows that the minimum angular separation for the reference GSO earth station provides sufficient off-axis gain to result in an EPFD↓ level[5] below the never-to-exceed EPFD↓ limit (columns 5-10).

[5] This is a transient event that lasts for a few seconds. The value shown is the peak (worst-case) value.

Table 4. Results of EPFD↓ calculations, for a worst-case, hypothetical GSO victim Earth Station

Worst-case EPFD Compliance

Beam EIRP/ ERP (dBW)	36/33.9	Worst-case antenna for EPFD	ITU-R S.1428	No of satellites in view	1
Beam gain/3dB beamwidth	35dBi/2.8°	Beam gain/3dB beamwidth	40.9 dBi/2.07°	No of beams transmitting	1
Bandwidth/ frequency	500MHz/19.6 GHz	Bandwidth/ frequency	500 MHz/19.6 GHz	No of carrier signals	1
Beam (boresight) pointing	Victim E/S	Beam pointing	GSO arc	ITU Article 22 Table 22-1C. EPFD limit no greater than -140 dBW/m$^{2/}$MHz. 70 cm antenna ITU-R S.1428-1	
Orbit (altitude/inclination)	500km/30°	Elevation angle to GSO	20°		
Kuiper IOT antenna (Victim collocated)	34° 13' 30.6" N 118 30' 00" W	Antenna size/efficiency	0.7m/65%		

Kuipersat downlink beam			**Victim S.1428 Earth station**				**Article 22 EPFD Compliance**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Arrival angle degrees	PFD dBW/m^2	SPFD dBW/MHz/m^2	Minimum off-axis separation angle to GSO arc degrees	Boresight gain dBi	Off-axis gain dBi	Relative receive gain difference dB	EPFD dBW/MHz/m^2	EPFD limit dBW/MHz/m^2	margin to limit dB
20	-97.2	-124.2	2.4	40.9	19.6	21.3	-145.5	-140.0	5.5
25	-95.9	-122.9	3.4	40.9	15.6	25.3	-148.2	-140.0	8.2
30	-94.8	-121.8	4.7	40.9	12.2	28.8	-150.6	-140.0	10.6
35	-93.9	-120.9	6.1	40.9	9.3	31.6	-152.4	-140.0	12.4
40	-93.1	-120.1	6.8	40.9	8.1	32.8	-152.8	-140.0	12.8
43	-92.6	-119.6	7.0	40.9	7.8	33.1	-152.7	-140.0	12.7

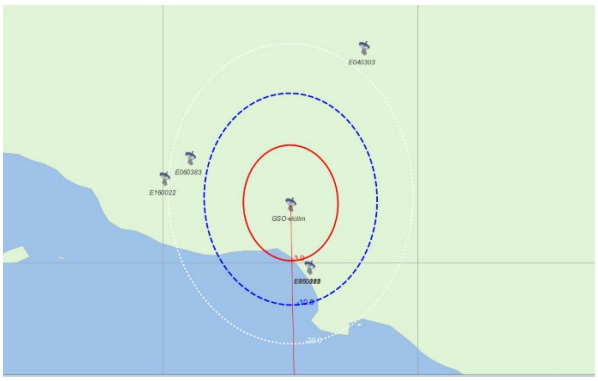
For the licensed GSO earth stations not co-located with the Kuiper experimental earth station, the experienced EPFD↓ will lower than the hypothetical worst-case values in Table 4 due to two factors:

- a sharp roll-off of the downlink beam off-axis gain outside of its 3dB footprint occurs which is shown in column 7 in table 2 and illustrated in figure 2 that depicts the -3 dB (red), -10 dB(blue) and -20dB (white) gain contours.
- at each licensed victim earth station, there will be a larger relative gain difference (column 7) due to each licensed antenna being larger than the 70 cm hypothetical victim used to calculate EPFD↓ in the table 4 above.

These 2 factors combined with the margin to EPFD↓ limit in column 10, means that the any interference to the licensed GSO earth stations is much lower than the column 8 values.

Arriving from the West

Departing to the East



Passing to the South

Figure 2. Downlink Gain on the earth surface illustrating the sharp roll off in gain in the direction of victim earth stations (earth stations > 50km away not shown)