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Response to FCC December 6, 2024 Information Request
File No. 1009-EX-CN-2024

December 20, 2024

MITRE Corporation ("MITRE") provides the following response to the above-referenced request for information:

A compatibility analysis demonstrating that the proposed experimental testing of MITRE's Satellite Experimentation Lab ("M-SEL") satellite network will be below the system noise floor of authorized receivers in the 1525-1559 MHz; 2170-2180 MHz; 2483.5-2500 MHz; 2500-2520 MHz; 4900-5000 MHz; and 6875-7055 MHz is attached hereto as Appendix A ("Compatibility Analysis"). MITRE is also concurrently submitting revised ITU documentation, including SpaceCap ("Revised SpaceCap"), GIMS, and cost recovery letter addressing additional issues raised in the request for information, including operations under ITU Radio Regulations, Article 4.4 and CR requirements in specific bands. Additional issues regarding specific downlink bands and other questions are addressed below.

1. *Please provide a compatibility analysis for the 1525-1559 MHz space-to-Earth transmission, taking into account footnote US315 and mark the operations as 4.4 in the SpaceCap as there is not an existing authorization in the table of frequency allocations. Additionally, submit this as a CR in accordance with footnote 5.354.*

See Appendix A Compatibility Analysis and Revised SpaceCap addressing these requests. MITRE recognizes that the 1530-1544 MHz band is subject to priority access for maritime mobile-satellite distress and safety communications (e.g., Global Maritime Distress and Safety System ("GMDSS")) and that communications of mobile-satellite stations not participating in the GMDSS are on a secondary basis. MITRE's proposed experimental testing would only be on a non-interference, non-protection basis to priority GMDSS and other authorized services in the band. As noted in the Compatibility Analysis, because MITRE's proposed operations would be below the system noise floor and would not cause harmful interference to GMDSS or emergency communications systems, required priority would always be maintained.

2. *Please mark the 1980-2010 MHz uplink as 4.4 operations in the SpaceCap as there is not an existing authorization in the table of frequency allocations.*

See Revised SpaceCap addressing this request.

3. *Please provide a compatibility analysis for the 2170-2180 MHz space-to-Earth transmission and mark the operations as 4.4 in the SpaceCap as there is not an existing authorization in the table of frequency allocations.*

See Appendix A Compatibility Analysis and Revised SpaceCap addressing these requests.

4. *Please provide a compatibility analysis for the 2483.5-2500 MHz space-to-Earth transmission, mark the operations as 4.4 in the SpaceCap as there is not an existing authorization in the table of frequency allocations. Additionally, submit this as a CR in accordance with footnote 5.402. Please indicate if you have coordinated these operations with Globalstar.*

See Appendix A Compatibility Analysis and Revised SpaceCap addressing these requests. As specified in the Compatibility Analysis, the interference-to-noise ratio of MITRE's proposed experimental testing will be below the system noise floor of authorized receivers in the 2483.5-2500 MHz band. Accordingly, while MITRE has not coordinated its proposed experimental operations with Globalstar, no interference into Globalstar's authorized operations is expected.

5. *Please provide a compatibility analysis for the 2500-2520 MHz space-to-Earth transmission, mark the operations as 4.4 in the SpaceCap as there is not an existing authorization in the table of frequency allocations.*

See Appendix A Compatibility Analysis and Revised SpaceCap addressing these requests.

6. *Please provide a compatibility analysis for the 4900-5000 MHz space-to-Earth transmission and mark the operations as 4.4 in the SpaceCap as there is not an existing authorization in the table of frequency allocations. Make sure to take into account US74 for Radio Astronomy Service ("RAS") operations. 4990-5000 MHz is allocated in the U.S. for RAS and Space research (passive) only.*

See Appendix A Compatibility Analysis and Revised SpaceCap addressing these requests. As specified in the Compatibility Analysis the interference-to-noise ratio of MITRE's proposed experimental testing will be below the expected system noise level of authorized receivers in the 4900-5000 MHz band. Nevertheless, MITRE recognizes that the 4990-5000 MHz band segment is allocated for RAS and Space Research (passive) services and will limit its proposed operations to 4900-4990 MHz to mitigate any potential harmful interference to such services in the adjacent 4990-5000 MHz band.

7. *Please provide a compatibility analysis for the 6875-7055 MHz space-to-Earth transmission and mark the operations as 4.4 in the SpaceCap as there is not an existing authorization in the table of frequency allocations. Make sure to take into account any potential for in-line interference events with other authorized operators in this frequency range.*

See Appendix A Compatibility Analysis and Revised SpaceCap addressing these requests. As specified in the Compatibility Analysis, the interference-to-noise ratio of MITRE's proposed experimental testing will be below the expected system noise floor of authorized receivers in the 6875-7055 MHz band. Moreover, as the proposed experimental testing is for a single non-geostationary satellite, any potential in-line interference impact to receivers on the earth is expected to be extremely limited.

8. *Please state whether the experimental is called "MITRE" or "M-SEL". If it is "M-SEL", please make sure to update the SpaceCap/GIMS and cost recovery letter. If "MITRE", no changes are required.*

The satellite is called the MITRE Satellite Experimentation Lab ("M-SEL"). This change is reflected in the Revised SpaceCap, GIMS, and cost recovery letter.

9. *Please state the mission duration. The narrative only states that the satellite will conduct orbit lowering for disposal 40 months after completion of the mission, not the duration of the mission itself, while the ODAR states the mission duration is 12 months. Additionally, why is there a 40 month gap between completion of the mission and start of disposal?*

The application Form 442 clarifies that the expected experimental program duration is 24 months. The reference to 12 months in the orbital debris assessment report is a typographical error. MITRE has also clarified in the Exhibit 1 Narrative that additional regulatory authority may be requested to the extent additional time is needed for experimental operations. (Exhibit 1, Narrative, 5) MITRE further clarifies that, unless extended or subsequent experimental testing is authorized for M-SEL, MITRE will promptly commence deorbit activities following the conclusion of experimental testing and there would not be a 40-month delay to begin this process. It will take around 9 months to fully de-orbit M-SEL once MITRE commences the deorbit process.

10. *Please redo the cost recovery letter. The entire contents need to fit on one page.*

A revised cost recovery letter has been uploaded to the application file.

11. *Please state which GPS signals you are requesting reception.*

M-SEL will receive GPS signals in L1 (1575.42 MHz).

Appendix A

Compatibility Analysis

The FCC has asked that MITRE Corporation ("MITRE") provide an analysis of the interference potential from proposed experimental testing with the M-SEL satellite in several downlink (space-to-Earth) frequency bands, including: 1525-1559 MHz; 2170-2180 MHz; 2483.5-2500 MHz; 2500-2520 MHz; 4900-5000 MHz; and 6875-7055 MHz. As demonstrated herein, MITRE's proposed operations are expected to be well below the noise floor in each of the analyzed frequency bands. Thus, MITRE's operations are not expected to pose any harmful interfere risks to incumbent authorized operations.

***Power Flux Density ("PFD") at the Surface of the Earth*:** We begin by determining the PFD at the surface of the earth from the M-SEL satellite for each of the frequency bands identified by the FCC. The PFD is calculated using the formula below.

$$S = \frac{P}{4\pi d^2}$$

Where S = PFD at the earth surface;
P = radiated power (Watts)
d = height of the satellite above the earth surface (510 km for M-SEL)

The values for each band are given in Table 1 below.

Frequency band (MHz)	**Radiated Power (Watts)**	**PFD (W/m^2)**
1525-1559	19.3	5.91×10^{-12}
2170-2180	18	5.51×10^{-12}
2483.5-2500	29.2	8.94×10^{-12}
2500-2520	29.2	8.94×10^{-12}
4900-5000	71.6	2.19×10^{-11}
6875-7055	15.8	4.84×10^{-12}

Table 1: PFD at the Surface of the Earth

***Received Power at Surface of the Earth*:** The PFD is then used to calculate received power on the surface of the earth, assuming that the receiving system uses an isotropic antenna, which has an aperture described by the formula below.

$$A = \frac{\lambda^2}{4\pi}$$

Where A = antenna aperture in m^2
λ = wavelength at the center of the band in m

Band (MHz)	Wavelength (m)	Aperture (m^2)	PFD (W/m^2)	Received Power (W)	Received Power (dBW)
1525-1559	0.19	0.0030	$5.91x10^{-12}$	$1.78x10^{-14}$	-137.5
2170-2180	0.14	0.0015	$5.51x10^{-12}$	$8.34x10^{-15}$	-140.8
2483.5-2500	0.12	0.0011	$8.94x10^{-12}$	$1.03x10^{-14}$	-139.9
2500-2520	0.12	0.0011	$8.94x10^{-12}$	$1.02x10^{-14}$	-139.9
4900-5000	0.061	0.00030	$2.19x10^{-11}$	$6.47x10^{-15}$	-141.9
6875-7055	0.043	0.00015	$4.84x10^{-12}$	$7.14x10^{-16}$	-151.5

Table 2: Received Power at the Surface of the Earth

The received power calculated in Table 2 considers the full power of the transmitted signal across the entire bandwidth identified in the emission designators specified in the application.

***Power Spectral Density*:** To determine the worst-case received power in each frequency band, the analysis below considers the smallest bandwidth used in each frequency band of 5 megahertz. The received power is converted to a power spectral density ("PSD") by dividing each received power level by 5,000,000 Hz (or by subtracting 67 dB) as calculated in Table 3 below.

Band (MHz)	Received PSD (W/Hz)	Received PSD (dBW/Hz)
1525-1559	$3.56x10^{-21}$	-204.5
2170-2180	$1.67x10^{-21}$	-207.8
2483.5-2500	$2.06x10^{-21}$	-206.9
2500-2520	$2.03x10^{-21}$	-206.9
4900-5000	$1.29x10^{-21}$	-208.9
6875-7055	$1.42x10^{-22}$	-218.5

Table 3: Received PSD

***Interference-to-Noise Ratio ("INR")*:** The received PSD values can be compared to the thermal noise level to determine the INR in each frequency band. The thermal noise level is calculated using the following formula:

$$N = kTB$$

Where N = noise power level
k= Boltzmann Constant ($1.38x10^{-23}$)
T = Temperature (290 K)
B = Bandwidth (1 Hz)

The thermal noise is calculated to be 4.00x10-21 Watts/Hz, or -203.9 dBW/Hz.

Assuming that the receivers in each of the identified bands operate with a noise figure of 3 dB (representing internal noise generated within the receiver), the system noise level is then calculated to be -198.9 dBW/Hz for an incumbent receiver. Table 4 below shows the INR for each band used by the M-SEL satellite.

Band (MHz)	INR (dB)
1525-1559	-3.6
2170-2180	-6.9
2483.5-2500	-6
2500-2520	-6
4900-5000	-8
6875-7055	-17.6

Table 4: Interference to Noise Ratio

As can be seen in Table 4, the INR ratios are all below the system noise level of any incumbent receiver, and in all but one case are at least 6 dB below that system noise level. Moreover, given that the experimental operations are for a single non-geostationary satellite and any potential impact to receivers on the earth is expected to be extremely limited. Thus, no harmful interference is anticipated from the proposed experimental downlink operations of the M-SEL satellite. Nevertheless, to the extent any harmful interference is reported in a given frequency band, MITRE will immediately cease operations in such band until the harmful interference is resolved. Accordingly, MITRE's proposed experimental operations are fully compatible with incumbent operations in the requested frequency bands.