

Interference Analysis for the “Meshbed” Satellite Modification for STA 1560-EX-ST-2019

Mission Summary

The Meshbed satellite is a 3U CubeSat architecture launched from the Indian Space Research Organization (ISRO) Polar Services Launch Vehicle (PSLV) tail number C47 on November 27th, 2019. The mission is for Meshbed to act as an on-orbit RF test and technology demonstration platform. Meshbed has two independent RF subsystems: a dipole UHF tape spring antenna connected to the primary radio used for tracking, telemetry and control (TT&C) at 401.3 MHz communicating with three ground stations in Windham, NY, Deadhorse, AK, and Fairbanks, AK, and a wideband Active Electronically Scanned Array (AESA) antenna connected to a wideband software defined radio to be operated at 2.4225 GHz, 5.295 GHz and 5.515 GHz during test campaign operations to the ground station in Bedford, MA.

This EMC analysis is for two additional earth stations that are proposed to be used with the Meshbed satellite for TT&C purposes. The first is located in Deadhorse, Alaska; the second is located close by in Fairbanks, Alaska. Because these locations will be used exclusively for TT&C, interference analysis will only be conducted at 401.3 MHz.

Summary of Spacecraft Orbit and RF Details

- Launch Date: November 27th, 2019
- Altitude: 505 km $\pm$ 20 km (3-sigma tolerance)
- Inclination: 97.48 degrees $\pm$ 0.2 degrees (3-sigma tolerance)
- Local Time of Descending Node: 10:30 -0/+15 min (3-sigma tolerance)

Table 1 - Space to Earth transmission details

Beam Name	Lower Frequency (MHz)	Center Frequency (MHz)	Upper Frequency (MHz)	Bandwidth (kHz)
TT&C	401.275	401.3	401.325	25
S-Band	2395	2422.5	2450	55,000
C-Band 1	5270	5295	5320	50,000
C-Band 2	5490	5515	5540	50,000

Summary of Analysis

This report analyzes Meshbed’s TT&C transmission beams to determine their potential for causing interference to national and international radio operations when transmitting to two additional earth stations. This report includes the noise falloff, transmit power, and geographic

analysis for the TT&C beam. The resulting noise and power signature for the beam defines the range of potential interference stakeholders.

We identified and coordinated with the closest interference stakeholder. After finding there would be no interference with them, we concluded that stakeholders further away would similarly experience no interference.

Timeouts and Deployment

Clearance of Meshbed to Integrate and Launch

Pursuant to the launch provider flight requirements document signed and dated March 13, 2019 by both ASI and the provider, Spaceflight, Inc. (SFI), the Meshbed spacecraft frequencies described herein have been supplied to SFI for analysis and cross reference against other payloads on the flight. Given the frequencies and powers provided, Meshbed has been cleared to launch and deploy with all other primary and secondary payloads upon the ISRO PSLV C47 launch. Deployment cadence of secondary payloads and exact separation timing are not shared with ASI. A detailed separation report will be provided within 90 minutes of separation from the launch vehicle and insertion into the mission orbit.

Separation Timing and Early Operations

Meshbed is designed to delay for no less than 30 minutes after separation from the launch vehicle before transmitting or receiving on the TT&C link. The TT&C link is low power at 0.543 dBW ERP, and based on the following analysis is not anticipated to interfere with Earth based operations.

Transmit Description - TT&C Link

Transmit frequency: 401.30 MHz

Transmitter bandwidth: 25 kHz

Maximum ERP: 31 dBm

Adjacent channel power (using GFSK and 25 kHz spacing) is typically -50 dBc, with a maximum adjacent power of -45 dBc.

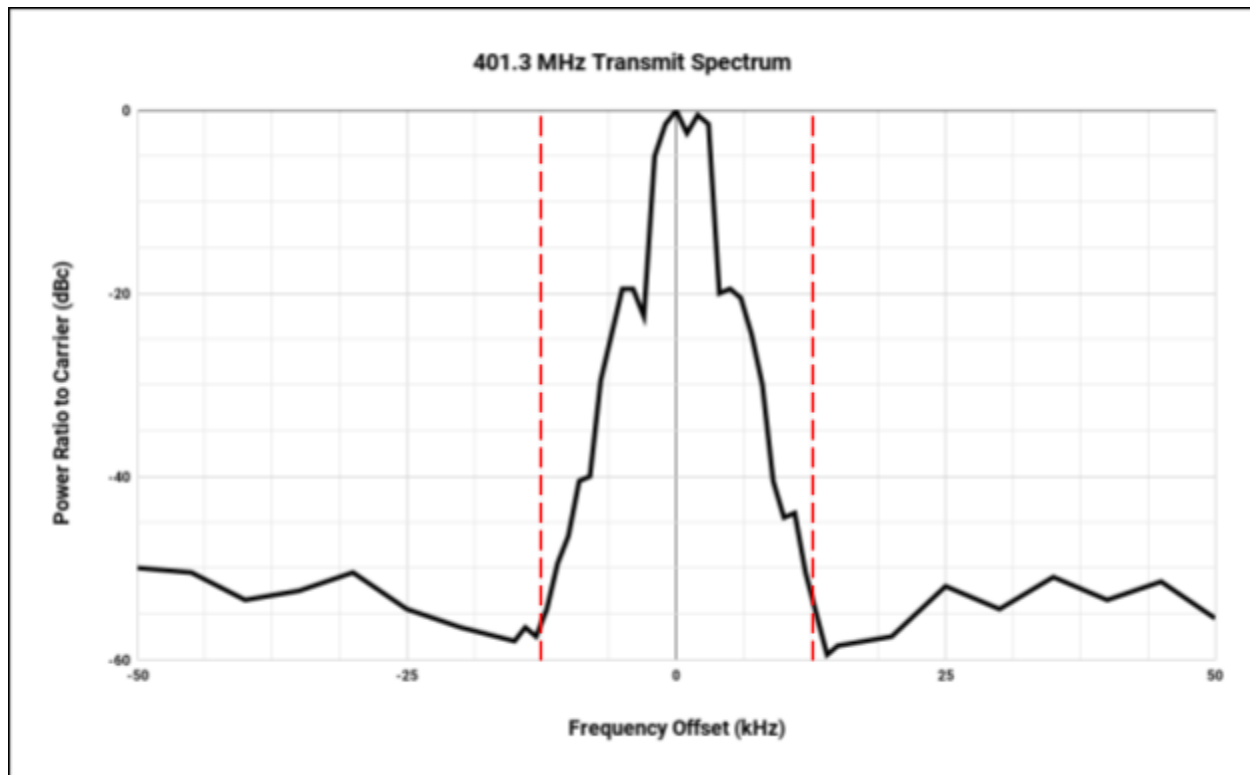


Figure 1 - Meshbed transmit spectrum efficiency. Red lines denote the 25 kHz bandwidth designation around 401.3 MHz.

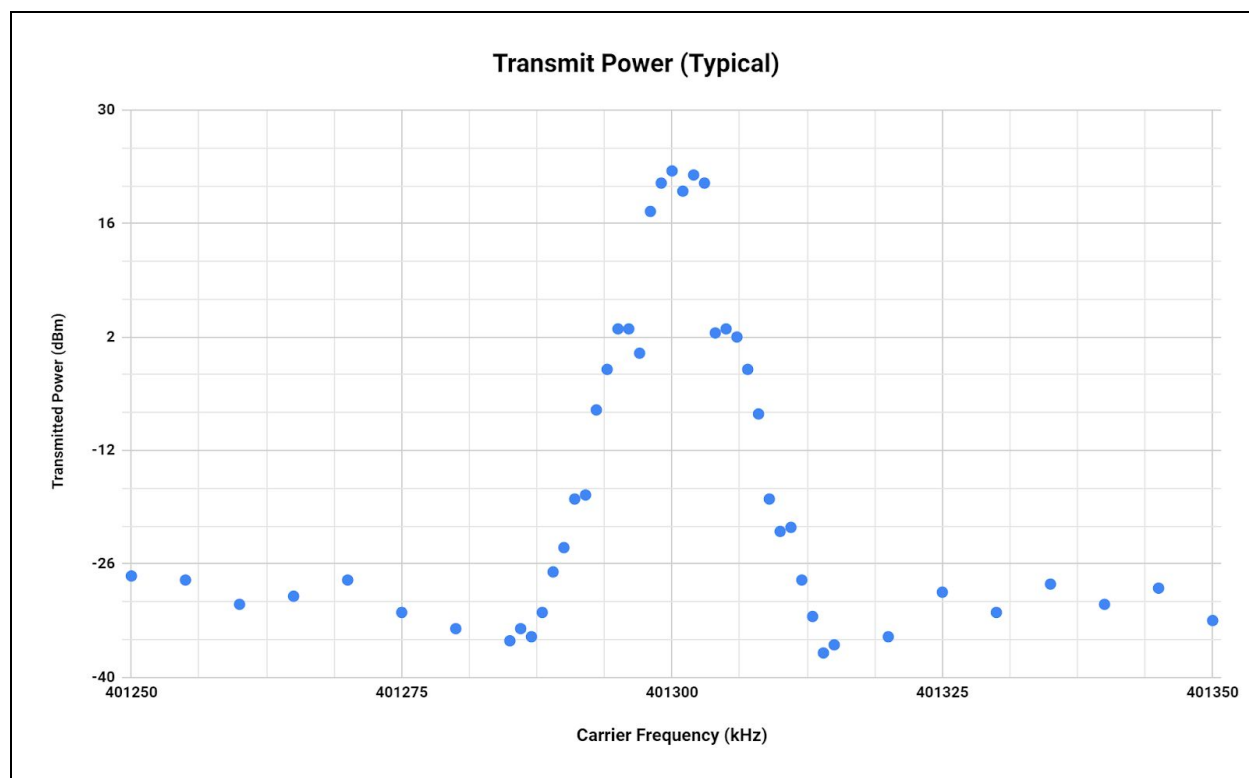


Figure 2 - Meshbed transmit power near 401.3 MHz.

Relevant Power and Power Flux Density Metrics

Transmit power at the antenna outside of the specified transmission band is at or below -27 dBm for all other frequencies. Furthermore, at the mission orbital altitude, all frequencies outside of the transmission band will be at or below a power flux density of -182 dB W/m² at Earth's surface when the spacecraft is directly overhead.

Deadhorse Domestic Operator Search

Relative to the additional TT&C ground station in Deadhorse, AK, the nearest ground station licensed to operate within the frequency of concern is operated by Planet Labs, and located in Fairbanks, AK (file number SES-MOD-20171002-01095, callsign E150030). This ground station is approximately 606 kilometers away from the Deadhorse site.

After coordinating with Planet operators, we conclude that our respective ground station operations are far enough away that we expect no interference. The next closest ground stations operating in the frequency are in Louisiana and North Dakota, 1,800 km away.

Fairbanks Domestic Operator Search

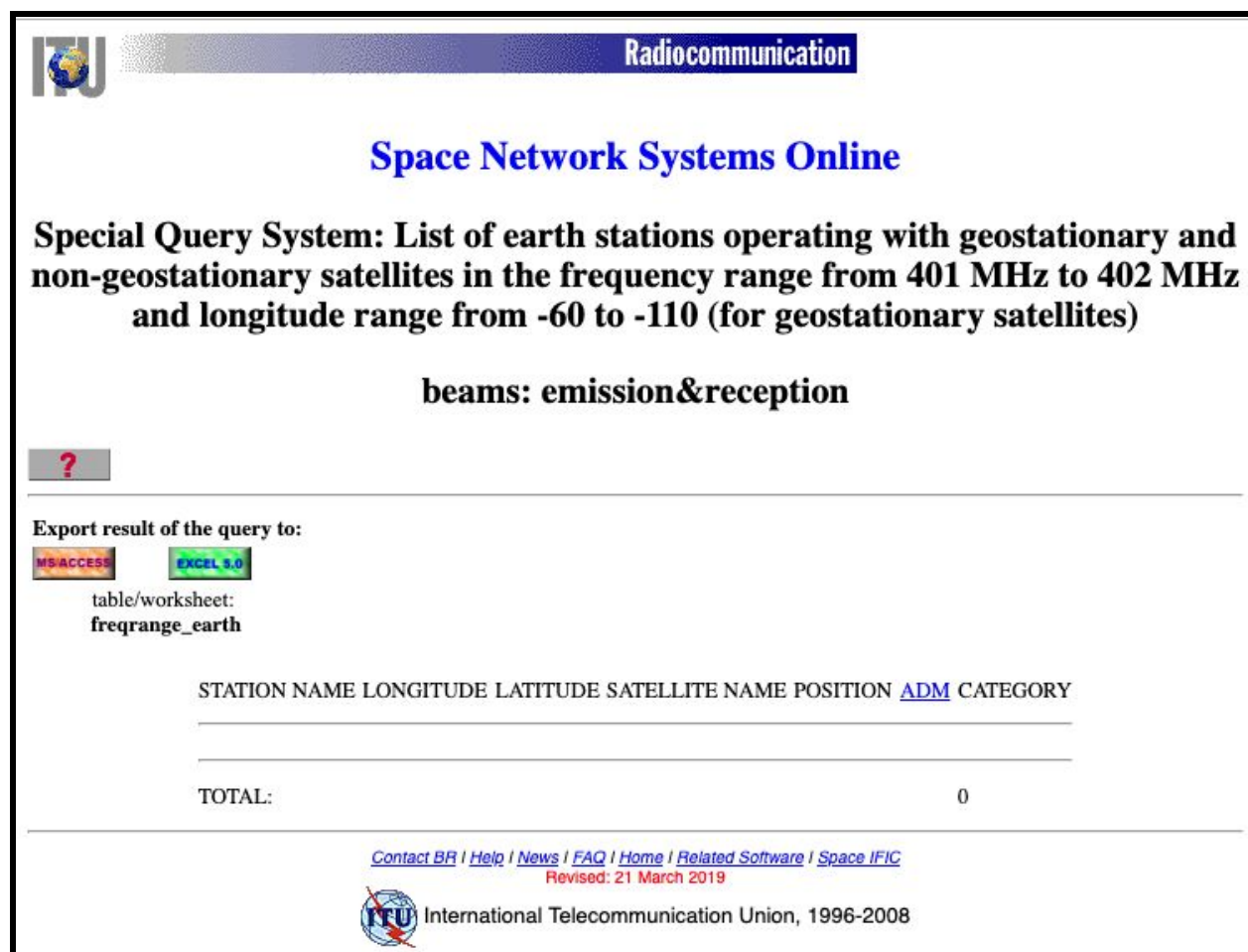
Relative to the additional TT&C ground station in Deadhorse, AK, the nearest ground station licensed to operate within the frequency of concern is the same as above, operated by Planet

Labs, and located in Fairbanks, AK (file number SES-MOD-20171002-01095, callsign E150030). This ground station is approximately 10 kilometers away from the Fairbanks site.

After coordinating with Planet operators, we found that the ground station would not be in use in that UHF band until mid-January 2020, negating the possibility of interference up until that time. We have determined that there will be no interference for the duration of the ground station operation in Fairbanks, and have set up communication channels to ensure that is the case. Similarly as above, the next closest ground stations operating in the frequency are in Louisiana and North Dakota, 1,800 km away.

International Operator Search

The TT&C 401.3 MHz downlink beam can bleed over national borders; we carried out broad searches to find stations to coordinate with.



ITU Radiocommunication

Space Network Systems Online

Special Query System: List of earth stations operating with geostationary and non-geostationary satellites in the frequency range from 401 MHz to 402 MHz and longitude range from -60 to -110 (for geostationary satellites)

beams: emission&reception

?

Export result of the query to:

MS/ACCESS **EXCEL 3.0**

table/worksheet:
freqrage_earth

STATION NAME	LONGITUDE	LATITUDE	SATELLITE NAME	POSITION	ADM	CATEGORY
TOTAL: 0						

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Revised: 21 March 2019

 International Telecommunication Union, 1996-2008

Figure 3 - Search criteria for international ground stations and results.

After a frequency search for all ITU registered ground stations in Canada over the Space Network Systems database, there are no Earth based operators in Canada licensed for 401.3

MHz. When performing a broader search, the closest international ground station is located in Daejeon, South Korea, more than 6,000 kilometers away. We therefore conclude there will be no interference.



Radiocommunication

Space Network Systems Online

Special Query System: List of earth stations operating with geostationary and non-geostationary satellites in the frequency range from 401.275 MHz to 401.325 MHz and longitude range from to (for geostationary satellites)

beams: emission&reception



Export result of the query to:



table/worksheet:
frequence_earth

STATION NAME	LONGITUDE	LATITUDE	SATELLITE NAME	POSITION	ADM	CATEGORY
KANEVSKA/AAPD	38.9667	46.0667	GOMS-M	76	RUS	N
B-KALIT2/AAPD	40.8167	48.2333	GOMS-M	76	RUS	N
ROST-D16/AAPD	39.7333	47.25	GOMS-M	76	RUS	N
YASHKUL/AAPD	45.35	46.1833	GOMS-M	76	RUS	N
SATREC KAIST KOREA	127.367	36.367	KITSAT-3		KOR	N
TOTAL:						5

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Figure 4 - Search criteria for international ground stations without longitudinal bounds and results.

Conclusion

Based on this analysis, there is no expectation at this time that Meshbed satellite operations will interfere with any known systems for the duration of the respective ground station operations.