

AST&Science – Downlink Interference Analysis
SAT-PDR-20200413-00034

AST&Science (“AST”) is providing further information and responses following the FCC’s letter request to evaluate potential SpaceMobile downlink interference in certain mid-band frequencies to any services allocated in the same band. AST’s analysis here demonstrates that the SpaceMobile system does not have the potential for interference to licensed or planned systems in the allocated services, other than one frequency band (1980-1990 MHz) where SpaceMobile will operate on non-interference basis.

AST’s SpaceMobile satellites will use LTE bands to provide Mobile Satellite Service (“MSS”) offerings to standard phones. The downlink frequencies of SpaceMobile to be used in the U.S. and the corresponding ITU and U.S. domestic allocations are summarized below in Table 1.

Table 1: Frequency Allocations in the Mid-Bands Requested by SpaceMobile

Frequency Range (MHz)	International Allocation	U.S. Domestic Allocation	Notes and Conclusions
1930-1970	FIXED MOBILE Mobile Satellite (↑)	FIXED MOBILE	SpaceMobile will operate under 4.4 for the downlink, and file for the uplink not under 4.4. ^{1/} No satellites other than SpaceMobile filed with the ITU in this band. No satellite systems, current or pending, are filed with the FCC. No Federal allocations. Non-Federal users are previously addressed wireless licenses and a small number of microwave licenses. SpaceMobile will not cause interference.
1970-1980	FIXED MOBILE	FIXED MOBILE	SpaceMobile will operate under RR 4.4. No satellites other than SpaceMobile filed with the ITU in this band. No satellite systems, current or pending, are filed with the FCC. No Federal allocations. Non-Federal users are previously addressed wireless licensees and a small number of microwave licenses.

^{1/} While SpaceMobile’s downlink in the U.S. will be under 4.4, AST is filing with the ITU for use of the band in the uplink according to the secondary MSS Region 2 allocation.

			SpaceMobile will not cause interference.
1980-1990	FIXED MOBILE MOBILE SATELLITE (↑)	FIXED MOBILE	SpaceMobile will operate under RR 4.4. Several non-GEO satellites filed with the ITU in this band (including SpaceMobile). No satellite systems, current or pending, are filed with the FCC. No Federal allocations. Non-Federal users are previously addressed wireless licensees and four microwave licensees. The use of this band for SpaceMobile will be subject to operating on a non-interference basis.
2110-2120	FIXED MOBILE SPACE RESEARCH (deep space ↑)	FIXED MOBILE	SpaceMobile will operate under RR 4.4. No Federal allocations. Non-Federal licensees with primary allocations are previously addressed wireless. SpaceMobile will not cause interference.
2120-2160	FIXED MOBILE Mobile Satellite (↓)	FIXED MOBILE	SpaceMobile will operate under Coordination Request. No domestic allocation (US, Canada, and Mexico). No Federal allocations. BRS is only co-primary until the end of 2021. SpaceMobile will not cause interference.
2160-2180	FIXED MOBILE MOBILE SATELLITE (↓)	FIXED MOBILE	SpaceMobile will operate under Coordination Request. No domestic allocation (US, Canada, and Mexico) for satellites. No Federal allocations. BRS is only co-primary until the end of 2021. SpaceMobile will not cause interference.
2345-2360	FIXED MOBILE RADIOLOCATION Amateur	FIXED MOBILE US100 BROADCASTING- SATELLITE RADIOLOCATION	SpaceMobile will operate under RR 4.4. No satellite systems, current or pending, filed with the FCC.

			No primary Federal allocations. No FCC licenses issued for Radiolocation, which is, in practice, secondary to the fixed and mobile services in U.S. SpaceMobile will not cause interference.
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The potential downlink interference from SpaceMobile to other services allocated in the same frequency bands can be separated into three cases:

- 1) SpaceMobile downlink potential interference to other satellite systems that use the same frequencies for their downlinks;
- 2) SpaceMobile downlink potential interference to other satellite systems that use the same frequencies for their uplinks; and
- 3) SpaceMobile downlink potential interference to licensees of other allocated services.

Case 1: SpaceMobile Downlink Interference to Other Satellite Downlinks

The concerned frequency bands in this case are 2120 MHz to 2180 MHz and 2345 MHz to 2360 MHz.

Although most, if not all, of the MSS satellites filed in 2020 MHz to 2180 MHz are for global coverage, none can provide service to the US, Canada or Mexico, because the bands between 2120 and 2180 MHz are not allocated domestically to satellite services in these countries. Therefore, there is no potential for downlink interference from SpaceMobile transmissions to the U.S. territory to the downlinks of other MSS satellites that might operate in this frequency band.

For the 2345 MHz to 2360 MHz band, there are no satellites licensed or requests to be licensed in the U.S. for this frequency band.

Case 2: SpaceMobile Downlink Interference to Other Satellite Uplinks

As indicated in Table 1, there are three frequency segments of SpaceMobile downlink frequencies that could be potentially shared with other satellite uplink frequencies. These three frequency segments are: (a) 1930 MHz to 1970 MHz; (b) 1980 MHz to 1990 MHz; and (c) 2110 MHz to 2120 MHz.

- a) 1930 MHz to 1970 MHz

This band is a secondary allocation of ITU for satellite uplinks in Region 2, but this allocation is not valid in the U.S. In addition, there are no satellite networks or systems filed with the ITU or the FCC in this band. Therefore, there is no potential for interference issue in the band.

b) 1980 MHz to 1990 MHz

Table 2 shows the NGSO satellites other than SpaceMobile filed with the ITU to use this band for uplink operations.

Table 2 Non-GEO satellite filed in the band 1980-2010 MHz (uplink)

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<u>satellite name</u>	<u>type</u>	<u>adm</u>	<u>ntwk org</u>	<u>category</u>	<u>longitude</u>	<u>freq_min</u>	<u>freq_max</u>
A4NG-C	N	F		C	-	1980.00000	2010.00000
AST-NG-C-1	N	F		C	-	1980.00000	2010.00000
AST-NG-C-2	N	F		C	-	1980.00000	2010.00000
AST-NG-C-3	N	F		C	-	1980.00000	2010.00000
AST-NG-C-4	N	F		C	-	1980.00000	2010.00000
EB-SAT-LEO-1	N	F		C	-	1980.00000	2010.00000
EB-SAT-LEO-1B	N	F		C	-	1980.00000	2010.00000
GONETS-M1	N	RUS		C	-	1980.00000	2010.00000
GW-1	N	CHN		C	-	1980.00000	2010.00000
HISPASAT-LEO-NB	N	E		C	-	1980.00000	2010.00000
KELYPSIS	N	CAN		C	-	1980.00000	1990.00000
M5L2SAT	N	PNG		C	-	1980.00000	2010.00000
MCSCS	N	CHN		C	-	1980.00000	2010.00000
OMNISPACE F2	N	PNG		C	-	1980.00000	1990.00000
OMNISPACE F2	N	PNG		U	-	1980.00000	1990.00000
OMNISPACE F2	N	PNG		N	-	1980.00000	1990.00000
PROGNOZ-N	N	RUS		C	-	1980.00000	2010.00000
SI-SAT-KURUKURU	N	SLM		C	-	1980.00000	2010.00000
SI-SAT-KURUKURU	N	SLM		U	-	1980.00000	2010.00000
SIRION-1	N	AUS		C	-	1980.00000	2010.00000
SIRION-1	N	AUS		U	-	1980.00000	2010.00000
SSG-CSL	N	G		C	-	1980.00000	2010.00000

TOTAL:

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The altitudes of these satellite systems vary from 410 km to 20,000 km.

To assess the potential interference, sample interference analyses to other satellite systems are performed. The configurations of the sample analyses are illustrated in Figure 1. The analyses include a case of a satellite system (Sat A) with the orbit altitude higher than SpaceMobile satellite altitude and a case of a satellite system (Sat B) with lower altitude. The analyses are performed for two extreme conditions: (1) the other satellites at the other side of Earth and are just visible by a SpaceMobile satellite; and (2) the other satellites are aligned with a SpaceMobile satellite with the same sub-satellite point.

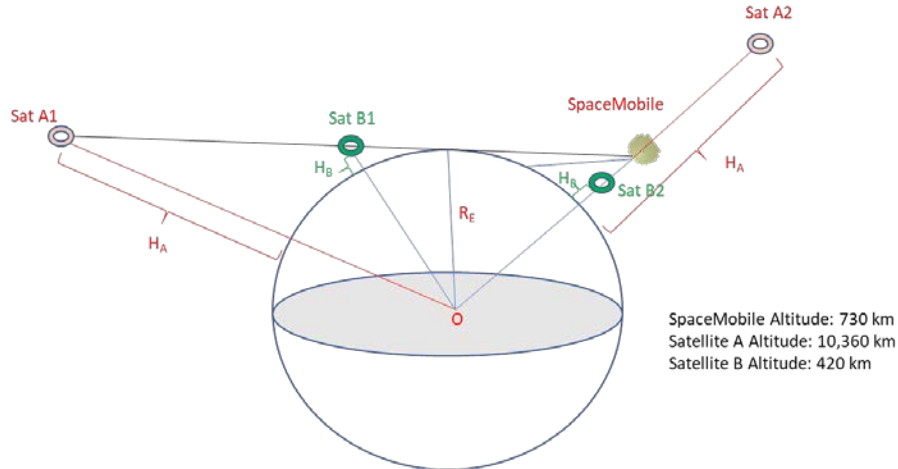


Figure 1 Configuration of Interference Analysis of SpaceMobile Downlink to Other Satellite Uplinks

Table 3 shows the assumptions and the results of the analyses. Based on the analyses, one can conclude the following:

- The potential SpaceMobile downlink interference to the uplink of a satellite with a higher altitude is typically low (for the case analyzed, the interference will be at least 15 dB below the noise floor) and can be acceptable. The higher the altitude, the lower the interference.
- There is potential higher level interference from SpaceMobile downlink to the uplink of a satellite with lower altitude.

To ensure that there is no unacceptable interference to the uplinks of the other satellites as listed in Table 2, SpaceMobile will use the 1980-1990 MHz downlink band on a non-interference basis and will only transmit in this band when there is no unacceptable interference to the other satellites filed using this band as their uplink band.

Table 3 Analyses of SpaceMobile Downlink Interference to Uplink of Other Satellites

SpaceMobile Parameter	Value	Unit
Satellite Altitude	730.0	km
Minimum Ground Service Elevation Angle	20.0	Degrees
Beam Pointing Direction at Edge of Service Area	57.5	degrees
Downlink Frequency	1980 - 1990	MHz
Beam Peak Gain at Edge of Service Area	45.3	dBi
Downlink Peak EIRP Spectrum Density at Edge of Service Area	46.8	dBW/MHz
Beamwidth of Edge Beam	0.9	Degrees
Beam Peak Gain at Center of Service Area	38.9	dBi
Downlink Peak EIRP Spectrum Density at Center of Service Area	40.4	dBW/MHz
Beamwidth of Center Beam	2.0	Degrees

Interference Evaluation	Satellite A		Satellite B		Unit
	A1	A2	B1	B2	
Location relative to SpaceMobile Satellite	A1	A2	B1	B2	
Other satellite orbit altitude	10360.0		420		km
Other satellite receive frequency range	1980 - 1990		1980 - 1990		MHz
Other satellite Rx antenna gain toward SpaceMobile	9.0	12	2	-10	dBi
Other satellite Rx noise temperature	316.0		450.0		K
Distance between SpaceMobile & other satellites	15470.5	9630.0	2351.2	310.0	km
Path loss	182.2	178.1	165.8	148.2	dB
Angular direction to other satellite from SpaceMobile beam boresight	6.3	180	6.3	0	Degrees
SpaceMobile gain towards the other satellite	13.2	0	13.2	38.9	dBi
SpaceMobile EIRP density towards the other satellite	14.7	1.5	14.7	40.4	dBW/MHz
SpaceMobile signal received by the other satellite	-158.5	-164.6	-149.1	-117.8	dBW/MHz
Other satellite noise floor	-143.6	-143.6	-142.1	-142.1	dBW/MHz
SpaceMobile Interference to other satellite I/N	-14.9	-21.0	-7.1	24.3	dB

c) 2110 MHz to 2120 MHz.

This frequency band is allocated as the uplink frequency to Space Research in Deep Space. Deep space is defined as space at distances from the Earth equal to, or greater than, 2×10^6 km. Based on the analyses above in b), there will be no unacceptable interference from SpaceMobile to the satellites for Space Research using this frequency band.

Case 3: SpaceMobile Downlink Interference to Other Allocated Services

As noted in Table 1, there are a small number of microwave licensees in 1930-1970 MHz, 1970-1980 MHz, and 1980-1990 MHz. As these frequencies also are licensed for wireless applications, a microwave license and a mobile license will not co-exist in the same area. SpaceMobile will use LTE frequencies licensed to AST's MNO partners, in their licensed areas. In addition, as indicated in case 2, SpaceMobile will operate in the 1980-1990 MHz band on a non-interference basis.

Additionally, in 2120-280 MHz, BRS licensees may only operate on a primary basis through the end of 2021. SpaceMobile, however, will not be in operation over the U.S. until after that time, and therefore interference to BRS would not be a concern.

In summary, SpaceMobile will not cause interference in these proposed operations, as demonstrated in the above analysis.

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING
ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application, that I am familiar with Part 25 of the Commission's rules, that I either prepared or reviewed the engineering information submitted in this application, and that it is complete and accurate to the best of my knowledge and belief.



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