Experimental Application Amendment

In this narrative, Omnispace LLC ("Omnispace") amends its pending application to request experimental operational authority for two non-geostationary orbit satellites ("OMNI-L1" and "OMNI-L2") for a five-year period starting as soon as feasible, clarifies the satellites will communicate with only one ground terminal, offers background and demonstrates rule compliance for the satellites, and addresses the latest FCC correspondence regarding Omnispace's orbital debris mitigation plan.

* * *

The OMNI-L1 and OMNI-L2 satellites will communicate with only one experimental prototype ground terminal previously requested and pending in the above referenced application docket.[1] Grant of this application, as amended, is in the public interest. The testing will enable Omnispace to continue developing equipment to provide low-cost, power-efficient internet-of-things services over satellite while building future communications capabilities for both commercial and U.S. military and government use.

Space and Earth Station Information

Omnispace owns and operates OMNI-L1 and OMNI-L2. Launched in 2022, the satellites are located at 630 km and 98 degrees orbital inclination.[2] The satellites will communicate with one ground terminal operating within a ten-kilometer radius of the Gainesville, GA centerpoint on a non-interference, non-protected basis using the following frequencies.[3]

Frequency (MHz)	Link Direction
1996-1998	Earth-to-space
2186-2188	space-to-Earth

Compliance with FCC Part 5 Space Station Provisions

The table below demonstrates Omnispace's compliance with the experimental satellite rules.[4]

Rule Part	Summary	Omnispace Response
5.64(a)	Construction of proposed experimental satellite facilities may begin prior to Commission grant of an authorization. Such construction is entirely at the applicant's risk and does not entitle the applicant to any assurances that its proposed experiment will be subsequently approved or regular services subsequently authorized. The applicant must notify the Commission's Office of Engineering and	Omnispace's satellites and facilities are already constructed, deployed, and operational under a Papua New Guinea authorization.

[1] Previous submissions inadvertently mentioned multiple terminals.

[2] The Papua New Guinea administration had authorized these satellites.

[3] Omnispace has submitted background on the ground terminal previously in this application docket.

[4] 47 C.F.R. § 5.64.

Rule Part	Summary	Omnispace Response
	Technology in writing that it plans to begin construction at its own risk.	
5.64(b)	Except where the satellite system has already been authorized by the FCC, applicants for an experimental authorization involving a satellite system must submit a description of the design and operational strategies the satellite system will use to mitigate orbital debris, including the following information:	
5.64(b)(1)	A statement that the space station operator has assessed and limited the amount of debris released in a planned manner during normal operations. Where applicable, this statement must include an orbital debris mitigation disclosure for any separate deployment devices, distinct from the space station launch vehicle, that may become a source of orbital debris.	OMNI-L1 and OMNI-L2 do not release any debris during normal operations.
5.64(b)(2)	A statement indicating whether the space station operator has assessed and limited the probability that the space station(s) will become a source of debris by collision with small debris or meteoroids that would cause loss of control and prevent disposal. The statement must indicate whether this probability for an individual space station is 0.01 (1 in 100) or less, as calculated using the NASA Debris Assessment Software or a higher fidelity assessment tool.	Omnispace satisfies this requirement. See Omnispace October 18, 2022 response to Reference No 71294 and January 9, 2023 response to Reference No. 73840.
5.64(b)(3)	A statement that the space station operator has assessed and limited the probability, during and after completion of mission operations, of accidental explosions or of release of liquids that will persist in droplet form. This statement must include a demonstration that debris generation will not result from the conversion of energy sources on board the spacecraft into energy that fragments the spacecraft. Energy sources include chemical, pressure, and kinetic energy. This demonstration should address whether stored energy will be removed at the spacecraft's end of life, by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy, or through other equivalent procedures specifically disclosed in the application.	Omnispace satisfies this requirement. See Omnispace May 31, 2022 response to Reference No 69362.

Rule Part	Summary	Omnispace Response
5.64(b)(4)	A statement that the space station operator has assessed and limited the probability of the space station(s) becoming a source of debris by collisions with large debris or other operational space stations.	Omnispace satisfies this requirement. See Omnispace May 31, 2022 response to Reference No 69362 and October 18, 2022 response to Reference No 71294.
5.64(b)(4)(i)	Where the application is for an NGSO space station or system, the following information must also be included:	
5.64(b)(4)(i)(A)	A demonstration that the space station operator has assessed and limited the probability of collision between any space station of the system and other large objects (10 cm or larger in diameter) during the total orbital lifetime of the space station, including any de-orbit phases, to less than 0.001 (1 in 1,000). The probability shall be calculated using the NASA Debris Assessment Software or a higher fidelity assessment tool. The collision risk may be assumed zero for a space station during any period in which the space station will be maneuvered effectively to avoid colliding with large objects.	Omnispace satisfies this requirement. See Omnispace May 31, 2022 response to Reference No 69362 and October 18, 2022 response to Reference No 71294.
5.64(b)(4)(i)(B)	The statement must identify characteristics of the space station(s)' orbits that may present a collision risk, including any planned and/or operational space stations in those orbits, and indicate what steps, if any, have been taken to coordinate with the other spacecraft or system, or what other measures the operator plans to use to avoid collision.	Omnispace satisfies this requirement. See Omnispace May 31, 2022 response to Reference No 69362 and January 9, 2023 response to Reference No. 73840.
5.64(b)(4)(i)(C)	If at any time during the space station(s)' mission or de-orbit phase the space station(s) will transit through the orbits used by any inhabitable spacecraft, including the International Space Station, the statement must describe the design and operational strategies, if any, that will be used to minimize the risk of collision and avoid posing any operational constraints to the inhabitable spacecraft.	Omnispace satisfies the large object collision risk requirement and further commits to coordinating with inhabitable space station operators when deorbiting the satellites. See Omnispace May 31, 2022 response to Reference No 69362 and January 9, 2023 response to Reference No. 73840.

Rule Part	Summary	Omnispace Response
5.64(b)(4)(i)(D)	The statement must disclose the accuracy, if any, with which orbital parameters will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s). In the event that a system will not maintain orbital tolerances, *e.g.,* its propulsion system will not be used for orbital maintenance, that fact should be included in the debris mitigation disclosure. Such systems must also indicate the anticipated evolution over time of the orbit of the proposed satellite or satellites. All systems must describe the extent of satellite maneuverability, whether or not the space station design includes a propulsion system.	The OMNI-L1 and OMNI-2 satellites would each maintain 630 km ± 5 (625-635 km) orbital altitude. See Omnispace May 31, 2022 response to Reference No 69362.
5.64(b)(4)(i)(E)	The space station operator must certify that upon receipt of a space situational awareness conjunction warning, the operator will review and take all possible steps to assess the collision risk, and will mitigate the collision risk if necessary. As appropriate, steps to assess and mitigate the collision risk should include, but are not limited to: contacting the operator of any active spacecraft involved in such a warning; sharing ephemeris data and other appropriate operational information with any such operator; and modifying space station attitude and/or operations.	Omnispace satisfies this requirement. See Omnispace October 18, 2022 response to Reference No 71294 and January 9, 2023 response to Reference No. 73840.
5.64(b)(4)(ii)	Where a space station requests the assignment of a geostationary orbit location, it must assess whether there are any known satellites located at, or reasonably expected to be located at, the requested orbital location, or assigned in the vicinity of that location, such that the station keeping volumes of the respective satellites might overlap or touch. If so, the statement must include a statement as to the identities of those parties and the measures that will be taken to prevent collisions.	N/A
5.64(b)(5)	A statement addressing the trackability of the space station(s). Space station(s) operating in low-Earth orbit will be presumed trackable if each individual space station is 10 cm or larger in its smallest dimension, exclusive of deployable components. Where the application is for an NGSO space station or system, the statement shall also disclose the following:	Both satellites have been assigned international designators and are trackable. See Omnispace May 31, 2022 response to Reference No 69362 and January 9, 2023 response to Reference No. 73840.

Rule Part	Summary	Omnispace Response
5.64(b)(5)(i)	How the operator plans to identify the space station(s) following deployment and whether space station tracking will be active or passive.	Omnispace tracks OMNI-L1 and OMNI-L2 using a unique telemetry marker and GPS receiver onboard each satellite.
5.64(b)(5)(ii)	Whether, prior to deployment, the space station(s) will be registered with the 18th Space Control Squadron or successor entity.	Omnispace satisfies this requirement. OMNI-L1's NORAD ID is 52157, and OMNI-L2's NORAD ID is 52771.
5.64(b)(5)(iii)	The extent to which the space station operator plans to share information regarding initial deployment, ephemeris, and/or planned maneuvers with the 18th Space Control Squadron or successor entity, other entities that engage in space situational awareness or space traffic management functions, and/or other operators.	Omnispace satisfies this requirement. See Omnispace October 18, 2022 response to Reference No 71294 and January 9, 2023 response to Reference No. 73840.
5.64(b)(6)	A statement disclosing planned proximity operations, if any, and addressing debris generation that will or may result from the proposed operations, including any planned release of debris, the risk of accidental explosions, the risk of accidental collision, and measures taken to mitigate those risks.	Omnispace will not execute planned proximity operations. See Omnispace May 31, 2022 response to Reference No 69362.
5.64(b)(7)	A statement detailing the disposal plans for the space station, including the quantity of fuel - if any - that will be reserved for disposal maneuvers. In addition, the following specific provisions apply:	Omnispace satisfies this requirement. See Omnispace May 31, 2022 response to Reference No 69362.
5.64(b)(7)(i)	For geostationary orbit space stations, the statement must disclose the altitude selected for a disposal orbit and the calculations that are used in deriving the disposal altitude.	N/A
5.64(b)(7)(ii)	For space stations terminating operations in an orbit in or passing through the low-Earth orbit region below 2,000 km altitude, the statement must disclose whether the spacecraft will be disposed of either through atmospheric re-entry, specifying if direct retrieval of the spacecraft will be used. The statement must also disclose the expected time in orbit for the space station following the completion of the mission.	Omnispace satisfies this requirement. See Omnispace May 31, 2022 response to Reference No 69362.
5.64(b)(7)(iii)	For space stations not covered by either paragraph (b)(7)(i) or (ii) of this section, the statement must indicate whether disposal will involve use of a storage orbit or long-term atmospheric re-entry and rationale for the selected disposal plan.	N/A

Rule Part	Summary	Omnispace Response
5.64(b)(7)(iv)	For all NGSO space stations under paragraph (b)(7)(ii) or (iii) of this section, the following additional specific provisions apply:	
5.64(b)(7)(iv)(A)	The statement must include a demonstration that the probability of success of the chosen disposal method will be 0.9 or greater for any individual space station. For space station systems consisting of multiple space stations, the demonstration should include additional information regarding efforts to achieve a higher probability of success, with a goal, for large systems, of a probability of success for any individual space station of 0.99 or better. For space stations under paragraph (b)(7)(ii) of this section that will be terminating operations in or passing through low-Earth orbit, successful disposal is defined as atmospheric re-entry of the spacecraft within 25 years or less following completion of the mission. For space stations under paragraph (b)(7)(iii) of this section, successful disposal will be assessed on a case-by-case basis.	Omnispace satisfies this requirement because no components will survive atmospheric reentry (which occurs within 25 years of mission completion). See Omnispace May 31, 2022 response to Reference No 69362, October 18, 2022 response to Reference No 71294, and January 9, 2023 response to Reference No. 73840.
5.64(b)(7)(iv)(B)	If planned disposal is by atmospheric re-entry, the statement must also include:	
5.64(b)(7)(iv)(B)(1)	A disclosure indicating whether the atmospheric re-entry will be an uncontrolled re-entry or a controlled targeted reentry.	Omnispace satisfies this requirement. See Omnispace May 31, 2022 response to Reference No 69362.
5.64(b)(7)(iv)(B)(2)	An assessment as to whether portions of any individual spacecraft will survive atmospheric re-entry and impact the surface of the Earth with a kinetic energy in excess of 15 joules, and demonstration that the calculated casualty risk for an individual spacecraft using the NASA Debris Assessment Software or a higher fidelity assessment tool is less than 0.0001 (1 in 10,000).	Omnispace satisfies this requirement. See Omnispace May 31, 2022 response to Reference No 69362, October 18, 2022 response to Reference No 71294, and January 9, 2023 response to Reference No. 73840.

APPENDIX
(Omnispace Responses to Correspondence Reference Number: 75326)

FCC Question 1: Please indicate the targeted level of risk reduction from the 1e-3 threshold for collision avoidance actions and address whether this targeted level of reduction is routinely achievable by the spacecraft and collision avoidance systems. In support, please provide a timeline of events from time of CDM notification to the time a collision avoidance maneuver decision is made by operators, and the duration of time to fully execute said maneuver.

Omnispace Answer 1: In addition to the information submitted to the FCC on October 18, 2022, Omnispace offers further information in this response. Omnispace takes seriously the issue of mitigation of the risk of collisions, whether from active or inactive space objects. Omnispace and its satellite manufacturers Thales Alenia Space and NanoAvionics receive timely conjunction data message (CDM) notifications from the U.S. Space Force that notify any close approach or conjunction events including the time of close approach, probability of collision, and the miss distance range to take the necessary steps to mitigate collision risks.

Omnispace uses a baseline threshold level of risk of collision of 1E-03 (> 1/1000). If the risk of collision is deemed greater than 1E-03, response steps include assessing the time of close approach, probability of collision, and the miss distance range. If another satellite operator is involved in the warning, Omnispace shares ephemeris information and conducts or delays propulsion and altitude operations, if necessary, in coordination with the other satellite operator. The OMNI-L1 and OMNI-L2 satellites have view of the satellite ground station several times per day (3-4 times per day for telemetry and commanding) and any operational commands for the satellites can be executed during those passes. Omnispace will target to reduce from a 1E-03 collision threshold to at least a 1E-04 (> 1/10,000) collision threshold. Following is a sample timeline of such a maneuver.

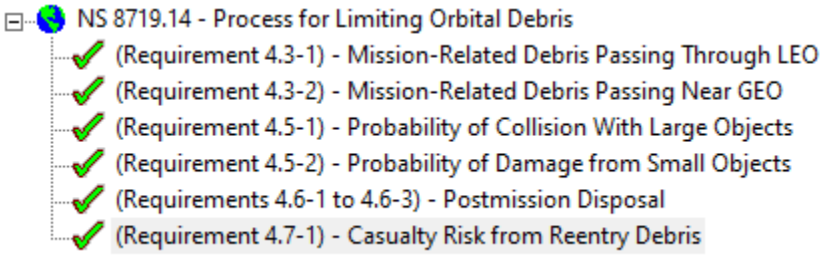
- Time duration between conjunction notification and collision avoidance maneuver, if required: 2 to 48 hours
- Time duration to fully execute said maneuver: minutes to 1 hour

FCC Question 2: Please provide the complete DAS logs supporting the orbital debris analysis.

Omnispace Answer 2: See attached DAS logs that support both satellites.

Exhibit A
(DAS Logs for Orbital Debris Analysis)

6.10 Annex – DAS Activity Logs



09 15 2022; 10:13:40AM Processing Requirement 4.3-1: Return Status : Not Run

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No Project Data Available
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========== **End of Requirement 4.3-1** ==========

09 15 2022; 10:13:49AM Processing Requirement 4.3-2: Return Status : Passed

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No Project Data Available
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========== **End of Requirement 4.3-2** ==========

09 15 2022; 10:21:36AM Processing Requirement 4.5-1: Return Status : Passed

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Run Data
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INPUT

Space Structure Name = Omnispace M12P
Space Structure Type = Payload
Perigee Altitude = 625.000 (km)
Apogee Altitude = 635.000 (km)
Inclination = 97.800 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass Ratio = 0.0150 (m^2/kg)
Start Year = 2022.040 (yr)
Initial Mass = 14.420 (kg)
Final Mass = 14.420 (kg)
Duration = 5.000 (yr)
Station-Kept = True
Abandoned = True
Long-Term Reentry = True

OUTPUT

Collision Probability = 6.8453E-06
Returned Message: Normal Processing
Date Range Message: Normal Date Range
Status = Pass

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========== End of Requirement 4.5-1 ==========

09 15 2022; 10:33:30AM Requirement 4.5-2: Compliant

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Spacecraft = Omnispace M12P
Critical Surface = Critical Surface

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INPUT

Apogee Altitude = 635.000 (km)
Perigee Altitude = 625.000 (km)
Orbital Inclination = 97.800 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass = 0.0150 (m^2/kg)
Initial Mass = 14.420 (kg)
Final Mass = 14.420 (kg)
Station Kept = Yes
Start Year = 2022.040 (yr)
Duration = 5.000 (yr)
Orientation = Random Tumbling
CS Areal Density = 2.590 (g/cm^2)
CS Surface Area = 0.0600 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = No
Outer Wall 1 Density: 2.590 (g/cm^2) Separation: 20.000 (cm)
Outer Wall 2 Density: 2.590 (g/cm^2) Separation: 20.000 (cm)
Outer Wall 3 Density: 2.590 (g/cm^2) Separation: 30.000 (cm)

OUTPUT

Probability of Penetration = 2.7809E-05 (2.7810E-05)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range

========== End of Requirement 4.5-2 ==========

09 15 2022; 10:26:14AM Processing Requirement 4.6 Return Status : Passed

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Project Data
==========

INPUT

Space Structure Name = Omnispace M12P
Space Structure Type = Payload

Perigee Altitude = 625.000000 (km)
Apogee Altitude = 635.000000 (km)
Inclination = 97.800000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.015000 (m^2/kg)
Start Year = 2022.040000 (yr)
Initial Mass = 14.420000 (kg)
Final Mass = 14.420000 (kg)
Duration = 5.000000 (yr)
Station Kept = True
Abandoned = True
PMD Perigee Altitude = 625.000000 (km)
PMD Apogee Altitude = 635.000000 (km)
PMD Inclination = 97.800000 (deg)
PMD RAAN = 0.000000 (deg)
PMD Argument of Perigee = 0.000000 (deg)
PMD Mean Anomaly = 0.000000 (deg)
Long-Term Reentry = True

OUTPUT

Suggested Perigee Altitude = 100.000000 (km)
Suggested Apogee Altitude = 635.000000 (km)
Returned Error Message = Passes Long-term reentry orbit criteria

Released Year = 2027 (yr)
Requirement = 63
Compliance Status = Pass

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========== End of Requirement 4.6 ==========

09 15 2022; 10:58:47AM *********Processing Requirement 4.7-1
Return Status : Passed

**********INPUT****
Item Number = 1

name = Omnispace M12P
quantity = 1
parent = 0
materialID = 9
type = Box
Aero Mass = 14.420000
Thermal Mass = 14.420000
Diameter/Width = 0.200000
Length = 0.300000
Height = 0.200000

name = Frame
quantity = 1
parent = 1
materialID = 9
type = Box
Aero Mass = 7.500000
Thermal Mass = 7.500000
Diameter/Width = 0.200000
Length = 0.300000
Height = 0.200000

name = Battery Pack
quantity = 3
parent = 1
materialID = 9
type = Box
Aero Mass = 0.300000
Thermal Mass = 0.300000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.020000

name = Solar Panel
quantity = 2
parent = 1
materialID = 23
type = Flat Plate
Aero Mass = 0.700000
Thermal Mass = 0.700000
Diameter/Width = 0.200000
Length = 0.600000

name = Payload
quantity = 1
parent = 1
materialID = 9
type = Box
Aero Mass = 1.500000
Thermal Mass = 1.500000
Diameter/Width = 0.100000
Length = 0.150000
Height = 0.100000

name = RW
quantity = 1
parent = 1
materialID = 9
type = Box
Aero Mass = 0.700000
Thermal Mass = 0.700000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.050000

name = FC
quantity = 1
parent = 1
materialID = 23
type = Box
Aero Mass = 0.150000
Thermal Mass = 0.150000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.020000

name = PC
quantity = 1
parent = 1
materialID = 23
type = Box
Aero Mass = 0.150000
Thermal Mass = 0.150000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.020000

name = S-Band
quantity = 1
parent = 1
materialID = 9
type = Box
Aero Mass = 0.250000
Thermal Mass = 0.250000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.030000

name = Propulsion
quantity = 1
parent = 1
materialID = 9
type = Box
Aero Mass = 1.250000
Thermal Mass = 1.250000
Diameter/Width = 0.100000
Length = 0.100000
Height = 0.100000

**********OUTPUT****
Item Number = 1

name = Omnispace M12P
Demise Altitude = 77.997953
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Frame
Demise Altitude = 71.016138
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Battery Pack
Demise Altitude = 75.660533
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Solar Panel
Demise Altitude = 76.961259
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Payload
Demise Altitude = 73.814401
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = RW
Demise Altitude = 74.011598
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = FC
Demise Altitude = 76.741823
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = PC
Demise Altitude = 76.741823
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = S-Band
Demise Altitude = 76.228214
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

****
name = Propulsion
Demise Altitude = 73.051589
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

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========== End of Requirement 4.7-1 ==========