Atomos Mission Description - Meson

Atomos Nuclear and Space Corporation (referred to as "Atomos"), based in Denver CO, is developing a fleet of orbital transfer vehicles (OTVs) with a mission to enable low-cost access to harder to reach orbits. In 2022, Atomos closed their Series A to fully fund their Mission-1 demonstration, secured $393M in signed LOIs from space operator and won three contracts under the U.S. Space Force Orbital Prime solicitation, providing an incredible opportunity to engage with government customers and end-users (including a meeting at the Pentagon). Atomos also presented at both National Space Council sessions for In-space Authorization and Supervision Policy and responded to the Federal Communications Commission's (the "Commission") Notice of Inquiry for In-Space Servicing, Assembly and Manufacturing.

In Q1 2024, Atomos will launch two spacecraft (Meson and Gluon) on the SpaceX Transporter 10 Vehicle for its Mission-1 demonstration. In this application, Atomos seeks Part 5 Special Temporary Authority to operate one of the two spacecraft, **Meson**.[1]

The two vehicles will launch mated together in the same slot and are expected to be deployed at approximately 515 km altitude in a sun-synchronous configuration. Once Meson and Gluon are safely separated from the launch vehicle and Atomos confirms that both spacecraft are operating nominally, Meson will lower both spacecraft approximately 15 km to a 500 km orbital altitude to further test the Meson's capabilities.

Once Meson has lowered the two spacecraft to the new orbit, approximately 500 km of altitude, Meson and Gluon will separate. After separation, Meson will perform a series of rendezvous and proximity operations (RPO) that will culminate in Meson and Gluon docking. At this point, Atomos's primary mission will be complete.

Once the docking procedure at the new orbit is complete, Atomos will test propellant transferring capabilities between Meson and Gluon. Depending on the resources available, Atomos may try additional separation, RPO, and docking tests. Finally, Atomos will use the remaining propellant to lower the altitude of both spacecraft and place them in an orbit that will speed reentry, and separate the two craft prior to reentry.

Please see below Figure 1 for a depiction of the various mission stages for Meson and Gluon.

[1] Atomos will file a separate application for authorization of its Gluon spacecraft.

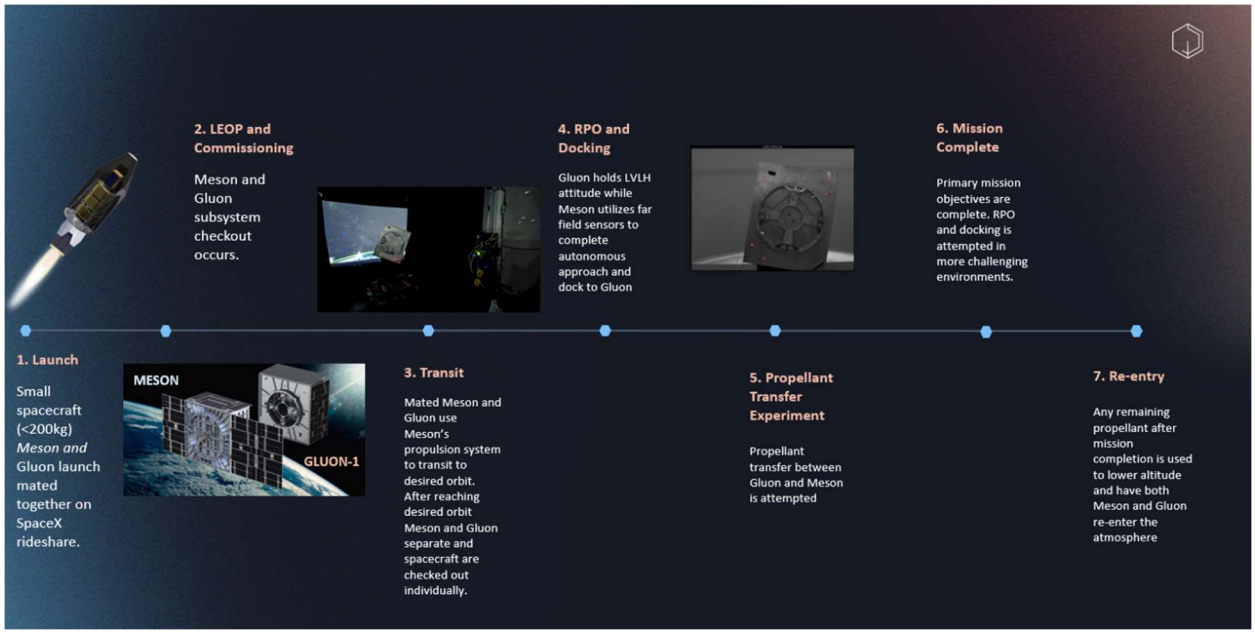

Figure 1: Mission 1 Timeline

Meson Vehicle

The Meson vehicle will be equipped with a two-part propulsion system consisting of a part that feeds the electric thrust system based on a resistojet thruster, while a cold-gas reaction control system is used for six degrees of freedom (6DOF) maneuvers during rendezvous and proximity operations. Both propulsion systems are ammonia-based, and all residual propellant at the end of the mission will be used to lower Meson's altitude to accelerate de-orbiting the Meson-Gluon stack. Additionally, Meson will be equipped with a sensor suite of two TIR cameras, two visible light cameras, and two single-point laser range finders. These sensors are all intended for spacecraft relative navigation purposes and will be used to identify the Gluon spacecraft to provide navigation inputs for rendezvous.

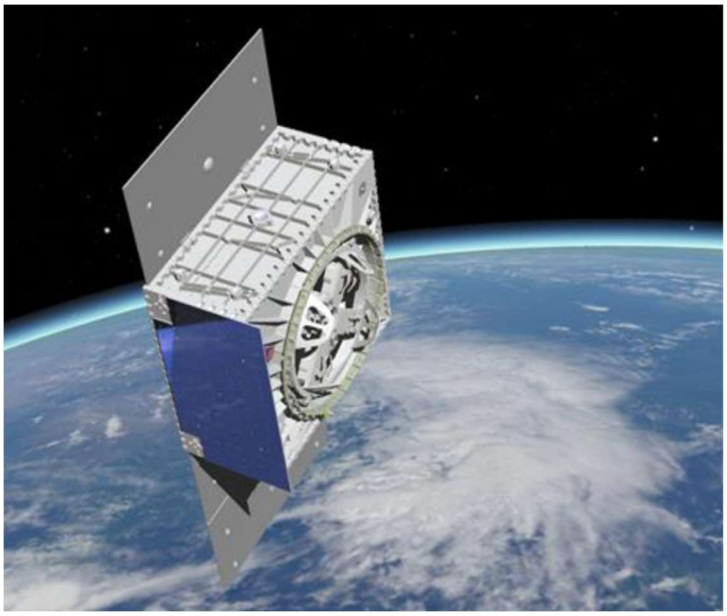

Figure 1: Meson Spacecraft

Mission Operations

For this mission, Atomos will manage spacecraft operations via its U.S. based Mission Operations Center (MOC).

For Meson, all commanding and telemetry downlinking is performed via space-to-space links through the Inmarsat (Addvalue) and Iridium (Near Space Labs) constellations. The Eyestar-S4 radio will be used to beacon telemetry by transmitting real-time data, and will also be able to receive commands sent from the MOC via the Iridium NSL network. All data will be encrypted to the AES-256 standard. Atomos will not deploy ground stations of its own, or work with an additional third-party ground station provider. Please see below for further information regarding the characteristics of communications between Meson and the Iridium System.

Meson will also include Wi-Fi antennas for intersatellite communication with Gluon during RPO. The Wi-Fi antenna will only transmit when the Meson and Gluon spacecraft are within 500 meters of each other.

Once commissioning is complete, and communications systems are directed at the Inmarsat network, then the Inmarsat Addvalue IDRS 100 radio will be used to transmit playback data (stored telemetry on-board the spacecraft) over the Inmarsat network. To cease emissions, Iridium will send a command over the Iridium constellation that will be sent via the on-board Eyestar radios, to the Atomos vehicles.

All data will be encrypted to the AES-256 standard. Since the demonstration will depend on these two constellations, Atomos will not deploy ground stations of its own, or work with an additional third-party ground station provider.

Frequency Bands
Meson will use the following frequency bands during the Mission-1 demonstration. Atomos is also providing data sheets for each transmitting antenna onboard Meson for the Commission's further information.

Table 1. Meson Spacecraft Frequency Summary

Band and Direction	**Frequency Range**	**Bandwidth (MHz) and Modulation**	**Usage**
Iridium Eyestar	1618.75-1626 MHz	.035 and DQPSK	Crosslink between Meson and the Iridium Constellation to relay communications with the MOC
Addvalue Inmarsat	1525 - 1660.5 MHz	.200 and QPSK	Crosslink between two spacecraft
Wi-Fi Link	2400 - 2500 MHz	20 and WiFi (802.11)	Crosslink between two spacecraft

NOAA Authorizations
All imaging sensors onboard Meson are intended only for relative navigation to Gluon during RPO. The mission will include non-earth imaging of our cooperative rendezvous target spacecraft Gluon. Atomos has confirmed with NOAA that it does not require a NOAA license for its Meson spacecraft.

Compliance with the Commission's Orbital Debris Mitigation Rules
The Meson spacecraft will comply with 47 C.F.R. 5.64 of the Commission's Rules. Atomos has provided an Orbital Debris Assessment Report (ODAR) with this application and has also included debris mitigation strategies related to debris release, small debris, accidental explosions, collision risks with large objects, trackability, planned proximity operations and its post-mission disposal plans.

Engineering Certification

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this modification, that I am familiar with Part 25 and Part 5 of the Commission's rules, that I have 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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