Orion Space

Experimental License application: 0867-EX-CN-2021

Responses to FCC questions

Correspondence reference number: 69102

1. **Please indicate that in the event the RROCI will need to perform collision avoidance that you will send the necessary commands to the spacecraft for it to propulsively maneuver to a safe location. Will the trajectory of any maneuvers also be screened for possible conjunctions prior to execution of any maneuver?**

   Yes, Orion Space will send the necessary commands for it to propulsively maneuver to a safe location.

   Yes, Orion Space will have the 18th SDS screen the trajectory of the proposed maneuver to ensure that the maneuver will not cause any further possible conjunctions.

   Here is the procedure that Orion Space will follow when a Conjunction Data Message (CDM) is received:

   a. Review the message and send the RROCI ephemeris update to 18 SDS,
   b. If the collision avoidance message indicates that the other object has propulsion, contact the other satellite operator to discuss the proper response,
   c. Calculate a new trajectory, based on analysis of options including attitude adjustment and/or propulsion to avoid the collision,
   d. Send proposed new trajectory from maneuvers to 18th SDS for review, and then
   e. Then, with the closest ground contact time, Orion Space will upload the corresponding commands in the minimum amount of time possible.

The spacecraft has the explicit ability to command the MPT to fire after commanding the ADCS to achieve an appropriate orientation. I.e., the operation / firing of the MPT is independent of other SC operations, and is contingent only on power being available to energize the MPT.

The command is the following:

```
mutation { fireThrusterCycle(numCycles: 1) }@192.168.1.70:8400
```

The `numCycles` defines how many firing cycles to execute.

The `mpt-service` configures the MPT unit parameters on startup to be:

- Preferred firing cycle of 1,6,2,5,4,3
- Firing rate of 1000 ms
- Inductor Charge Time of 60uS (for vacuum operation)

1. **Please define the risk thresholds and lead time limits that inform whether and when an avoidance maneuver is required, the sequence of events from when a CDM is received to the time a collision avoidance maneuver is executed, etc. with expected timeframes.**

   The risk thresholds that prompt a CDM from 18 SDS will trigger the Orion Space conjunction response plan. The sequence of events is listed in response to Question 1 above, and repeated here with time information included:

   a. Review the message and send the RROCI ephemeris update to 18 SDS, This step is expected to be completed within one (1) hour of receipt of a CDM during regular work hours. Evenings and weekends, this step is expected to be completed within three (3) hours of receipt of a CDM.
   b. If the collision avoidance message indicates that the other object has propulsion, contact the other satellite operator to discuss the proper response, This step is expected to be completed within one (1) hour after the ephemeris data has been submitted to 18 SDS.
   c. Calculate a new trajectory, based on analysis of options including attitude adjustment and/or propulsion to avoid the collision, This calculation is expected to be completed by 2-4 hours after receiving a CDM.
   d. Send proposed new trajectory from maneuvers to 18th SDS for review. This step is expected to be completed approximately 2-4 hours after receiving a CDM.
   e. Then, with the closest ground contact time, Orion Space will upload the corresponding commands in the minimum amount of time possible. 18 SDS specifies that it's review of the new trajectories could take 8 hours or more from submission of the information. Given RROCI's orbital period of about 96 minutes, the earliest it might be possible to send a command to instruct the satellite to use propulsion to avoid a conjunction is about 13 hours after receipt of a CDM. Typically, the CDM provides an alert of a possible conjunction 72 hours prior to the prospective conjunction. While it may not always be possible to meet the 13 hour turnaround on a propulsion command, Orion Space is committed to working quickly and thoroughly to ensure that its response to a CDM is promptly communicated to RROCI to ensure protection of RROCI and of other space vehicles.

The analysis for closest ground contact time could be on the order of hours, however there is no warm-up time for the thrusters. To summarize, the expected timeframe is a combination of the time of analysis and the time until ground contact which is on the order of hours (< 24 hours).

2. **Please state the expected ability of the spacecraft to successfully respond to a conjunction warning which requires a propulsive maneuver. Will the spacecraft be able to avoid a predicted collision using the included propulsive system? Is there a minimum amount of time before a potential collision that the RROCI would be unable to effectively respond through use of a propulsive maneuver?**

   The current propulsion system can change our orbit altitude 1 km for every 8 hours of thrusting.

   Given the CDM response procedure set forth above, RROCI would not be able to effectively respond using propulsion if it received a warning only 13 hours or fewer before the projected collision. Some of that time is required for review of the proposed trajectory, which has to be performed by 18 SDS. However, since 18 SDS expects to send CDM's 72 hours before a projected collision, it is not anticipated that this would curtail RROCI's propulsive response to a CDM.

   If the CDM requires an orbit altitude adjustment of more than 1 km, then the time for the propulsive response will need to be increased by more than 8 additional hours.

   RROCI's engineering team has worked on two types of collision avoidance maneuvers. Not only can the satellite use propulsion, but the satellite's attitude can be adjusted to increase drag, slowing the apparent velocity of the orbit, and thereby avoiding the potential conjunction. This type of maneuver in response to a CDM would be subject to review and approval by 18 SDS before it was selected as the conjunction response.

   In all circumstances, the Orion Space response to a CDM will be to work swiftly to plan a new flight path for RROCI, as needed, and secure approval for that new flight path with 18 SDS, and then implement the corrective action as quickly as the commands can be transmitted to the spacecraft.

3. **Please confirm that you will be conducting coordination with inhabitable space stations during the deorbit/orbit lowering process.**

   Orion Space will be conducting coordination with the necessary parties of inhabitable space stations during the deorbit process. The deorbit process will involve continuous thrust to slow down our spacecraft in order to lower the orbit.