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Author: Mr. Kir Latyshev
Russian Federation

Mr. Aleksandr Khokhlov
The Russian State Scientific Center for Robotics and Technical Cybernetics, Russian Federation
Mr. Anton Matveev
Russian Federation
Ms. Darya Nemirich
Space Generation, Russian Federation

THE TRAJECTORY ANALYSIS AND POSSIBLE ARCHITECTURE OF MANNED VENUS AND MARS FLYBY MISSION IN 2021-2023 YEARS.

Abstract

In this work our team investigated the possibility of carrying out a double flyby mission (with Venus and Mars encounters) for the crew of 2, with Earth departure in 2021, Earth return in 2023 and the total time of flight of approximately 590 days. The mission requires 6 launches and on-orbit assembly in low Earth orbit (LEO).

We conducted trajectory analysis and designed a possible mission architecture – defined the concept of operations, outlined the flyby vehicle design, selected the launch vehicles and upper stages necessary for implementing the mission. For the transportation system drafted we determined the launch window and chose the nominal flight trajectory.

A trajectory includes a single propulsive maneuver at Earth, transfering the manned flyby vehicle from its initial parking LEO to a free-return Earth-Venus-Mars-Earth (EVME) trajectory which ends with the descent module with the crew entering Earth's atmosphere. Chemical propulsion is used for the trans-Venus injection (TVI) maneuver. Launch window: 11/17/2021 – 11/23/2021 (the launch window width is 7 days). Various EVME trajectories were found for different launch dates (from 11/17/2021 to 01/20/2021) and Mars flyby altitudes. Flight time is maximal at the beginning of the date range and decreases for later dates. Also lesser Mars flyby altitudes correspond to lesser flight times.

The mission requires 6 launches. The transportation system includes the following components: 1) the flyby vehicle (FV) which consists of the living module docked with the modified Soyuz spacecraft, 2) two upper stages which perform the TVI maneuver: the oxygen/hydrogen heavy class upper stage and heavy-lift upper stage (HLUS), 3) launch vehicles and fuel tankers for the HLUS: 2 fuel tankers; 6 launch vehicles:1 Ariane-5, 3 Proton-M, 1 Angara-A5, 1 Soyuz-2; Main limitation of the mission design was the use of either existing or prospective launchers that are to be in operation by the established launch date.

A manned deep space expedition is one of the crucial stages of exploration of the Solar system. With flyby mission planning we hope to bring the time of human presence on the other planets a little closer.

The work was presented at the International Gemini Mars Design Competition.