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DEVELOPMENT ROADMAP AND MISSION ARCHITECTURE DESIGN FOR HUMAN MARS EXPLORATION MISSION

Abstract

With the development of human society and deep space exploration technology, human Mars exploration has become more and more attractive. The human Mars exploration is of great significance in exploring extraterrestrial life, interplanetary migration, international cooperation and exchange, promoting the development of science and technology, and promoting the progress of human society. It is important to design the development roadmap and mission architecture for human Mars exploration. This study proposes a three-step development roadmap and its specific mission architecture options. The first step is Mars robotics exploration. This stage can also be called as the technical preparation stage for human Mars mission, which can demonstrate key technologies and reduce the technical risks of human mission. And for this step, a typical Mars sampling and return mission architecture using Long March 9 rocket is proposed. The second step is initial human Mars exploration, which can also be called as technology maturity and preliminary application stage. During the initial human missions, due to lack of experience and TRLs. Therefore, the human missions also need to be from easy to difficult. Therefore, this stage is divided into the three sub-stages: (1) human Mars orbiting exploration or Phobos and Deimos human landing mission; (2) human Mars landing mission; (3) establishing an initial Mars base. And for this step, four mission architecture options are proposed. Option one is a architecture based on chemical propulsion and aerodynamic deceleration. The option two is based on the nuclear thermal propulsion. The option three is based on the nuclear thermal + nuclear electric hybrid power vehicle. The option four is based on the nuclear electric ferry stage + nuclear thermal transfer carrier relay combination. The third step is routine human Mars explorations, which can also be called as technology upgrade and the stage of Earth-Mars economisphere formation. The mission architecture of this step will largely depend on the development of propulsion technology. When nuclear propulsion technology is not yet fully mature, chemical propulsion can be used to implement space transportation in the form of large-scale transportation systems or fleets. When nuclear thermal propulsion technology is mature, the use of nuclear thermal propulsion technology will further enhance the the space transportation capacity. When nuclear fusion technology is mature, it will greatly change the mode of space missions. And for this step, three mission architecture options are proposed. For each step. the corresponding key technologies are analyzed.