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A TECHNOLOGY ARCHITECTURE FOR ACCESSING THE OCEANS OF ICY WORLDS

Abstract

The icy moon oceans beckon with ingredients that potentially may harbor extant life. Beginning with the Galileo and Cassini missions, measurements have revealed the presence of global oceans under the icy crust of several moons of Jupiter and Saturn. Among those moons, Europa and Enceladus have their ocean in contact with the rocky core, providing an environment similar to the conditions existing on the terrestrial sea-floor where life has developed at hydrothermal vents. Accessing these oceans presents considerable difficulty due to a number of issues including the depth and composition of the icy crust, the time needed to travel through the crust, the power needed to propel a probe, communication of scientific and engineering data though the ice and back to earth, entry and mobility in the ocean and autonomous operations for the life of the mission.

A detailed trade space study was conducted to develop a technology architecture defining a system that would access an icy moon's ocean. To specifically bound the architecture, Jupiter's moon Europa was chosen as the target body though the work can apply to other bodies. The current understanding of the scientific properties of the ice crust and ocean was used to guide the development. A strawman scientific payload was devised to further develop a baseline set of requirements. Beginning with a launch and trajectory that can bring a system to Europa's orbit, a complete trade space was developed outlining the engineering systems needed to access the ocean. The architecture was divided into specific phases for i) deorbit, descent and landing, ii) surface operations, iii) ice descent and iv) ocean access.] The technical maturity of each of sub-system for the phases was assessed for systems that could be developed to a maturity ready for a preliminary design in 5-10 years. Integrated system parameters on power, communication capacity, and mass were developed to further define the overall system. To constrain the design, a total time in the ice, from the ice crust surface to accessing the ocean was limited to two years, and 10Km of ice was baselined with a temperature profile through the ice estimated from the scientific literature.

The results of this architecture will be presented in the paper.