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Technology perspectives in the future exploration of extreme environments

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Solar System exploration is driven by high priority science goals and objectives at diverse destinations, as described in the NRC Decadal Survey and in NASA's 2006 Solar System Exploration (SSE) Roadmap. Proposed missions to these targets encounter extreme environments, including high or low temperatures, high pressure, corrosion, high heat flux, radiation and thermal cycling. These conditions are often coupled, such as low temperature and high radiation at Europa; and high temperature and high pressure near the surface of Venus. Mitigation of these environmental conditions frequently reaches beyond technologies developed for terrestrial applications, for example, by the automotive and oil industries. Therefore, space agencies require dedicated technology developments to enable these future missions. Within NASA, proposed missions are divided into three categories. Competed small (Discovery class) and medium (New Frontiers class) missions are cost capped, thus limiting significant technology developments. Therefore, large (Flagship class) missions are required not only to tackle key science questions which can't be addressed by smaller missions, but also to develop mission enabling technologies that can feed forward to smaller missions as well. In a newly completed extreme environment technology assessment at NASA, we evaluated technologies from the current State of Practice (SoP) to advanced concepts for proposed missions over the next decades. Highlights of this report are discussed here, including systems architectures, such as hybrid systems; protection systems; high temperature electronics; power generation and storage; mobility technologies; sample acquisition and mechanisms; and the need to test these technologies in relevant environments. It is expected that the findings – documented in detail in NASA's Extreme Environments Technologies report – would help identifying future technology investment areas, and in turn enable or enhance planned SSE

missions, while reducing mission cost and risk.