

SPACE SYSTEMS SYMPOSIUM (D1)
Enabling Technologies for Space Systems (2)

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INNOVATIVE TECHNOLOGIES FOR HUMAN EXPLORATION: OPPORTUNITIES FOR
PARTNERSHIPS AND LEVERAGING NOVEL TECHNOLOGIES EXTERNAL TO NASA**Abstract**

Human spaceflight organizations have ambitious goals for expanding human presence throughout the solar system. To meet these goals spaceflight organizations have to overcome complex technical challenges for human missions to Mars, NEOs, and other distant celestial bodies; such as advancements in human health and countermeasures for space environments; self-sustaining habitats; advanced power and propulsion systems; and information technologies. Developing solutions to these challenges requires considerable resources and technological innovations. To date, government space agencies are exploring cooperative endeavors to reduce cost burdens, improve human exploration capabilities, and foster knowledge sharing among human spaceflight organizations. This paper looks at potential opportunities for partnerships and spin-ins from economic sectors that are historically less connected to space exploration. It highlights innovative technologies and breakthrough concepts that could have significant impacts on space exploration and identifies organizations throughout the broader economy specializing in these technologies.

Under the direction of NASA's Exploration Systems Mission Directorate (ESMD), Directorate Integration Office (DIO) The Tauri Group with NASA's Technology Assessment and Integration Team (TAIT) have completed several studies that identify novel technologies with potentially high payoff for human exploration and documented results via white papers. Additionally, these studies sought to identify potential organizations for partnerships; as well as identify organizations that NASA has not traditionally collaborated with but have technologies with the potential of translating into human exploration applications. The technology intelligence gathering activities are supported by a constantly-updated relational database of more than 400 externally-funded technologies, which are relevant to current exploration challenges. The technologies identified provide opportunities for leveraging external resources and identifying partners to meet exploration challenges, thereby reducing the cost of overcoming these challenges. The approach to identifying potential spin-in technologies and partnerships could apply to other national space programs, as well as international, multi-government, activities.

This paper will provide a brief overview of NASA's Technology Horizons Game-Changing and Technology Frontiers Breakthrough Technology Reports as well as the External Government Technology Dataset.

This paper will also highlight novel technologies drawn from these sources that could significantly impact space exploration capabilities and be infused from government and commercial sources into space exploration programs. Key technology areas identified will include virtual worlds, human augmentation, synthetic biology, and novel computing architectures. Lastly, a summary discussion of the impacts these technologies may have on enabling space exploration, and the benefits of collaborating with commercial, government, and academic organizations to infuse innovative capabilities into exploration architectures will be explored.