Paper ID: 54704
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IAF HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Utilization & Exploitation of Human Spaceflight Systems (3)

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INTERNATIONAL SPACE STATION, DEEP SPACE GATEWAY AND FUTURE COMMERCIAL STATIONS AS PLATFORMS FOR MICRO AND SMALL SAT ASSEMBLY, FUELING AND REFUELING

Abstract

Current trends in space call for increased robotic satellite servicing, on orbit assembly and refueling activity. Alongside new commercial space stations such as the proposed Orion Span, Axiom, and Bigelow, these robotic capabilities will enable new architectures for space exploration and utilization and new business models.

Spacecraft designs have historically been limited to configurations that can fit within a single rocket faring. As such, designs are limited in size and purpose. Fueling Small spacecraft (CubeSat scale and above) at space station can enable extremely high delta-V missions, with propellant mass fractions over 90

Complimenting this, deployable flexible tanks can be stowed into small volumes for launch and expanded and filled on orbit will allow for changes in the launch paradigm. Moving water from earth to space station in dedicated water taxis or as large volumes aboard ISS resupply missions increases economies of scale. Orbit Fab has developed, flown and tested a prototype water flex tank aboard the ISS via Project Furphy, funded in part by ISS NL and by commercial investment.

Some spacecraft components (specifically antennae and solar arrays) do not scale well to CubeSat or Small Sat buses. These systems limit the effective functionality of deep space MicroSat missions. As such, on-orbit manufactured or assembled systems are particularly attractive to deep space exploration MicroSat concepts. A complete paradigm shift can be achieved by combining in-orbit 3D printing of spacecraft structures, tanks, and antennas with an in-orbit fueling capability, enabling spacecraft configurations not previously possible.

This paper examines the state of the art in Astronaut serviced in space manufacturing, fueling and space assembly and deployment. It details the lessons learned and technical work undertaken by the Authors at Orbit Fab in the development of flexible toroidal CubeSat compliant fuel tanks or 'FlexTanks'. It goes on to recommend next steps and deployment regimes along alongside a case study of a high delta-V mission enabled by Space Station fueled and deployed MicroSats for deep space exploration.