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IN-ORBIT ASSEMBLY OF LARGE SPACECRAFT USING SMALL SPACECRAFT AND INNOVATIVE TECHNOLOGIES

Abstract

The size of any single spacecraft is ultimately limited by the volume and mass constraints of currently available launchers, even if elaborate deployment techniques are employed. Costs of a single large spacecraft may also be unfeasible for some applications, due to the increasing cost and complexity of very large monolithic components such as polished mirrors.

"In-orbit assembly" will be required to address missions with large infrastructures or large instruments/apertures for the purposes of increased resolution or sensitivity. This can be achieved by launching multiple smaller spacecraft elements with innovative technologies to assemble (or self-assemble) once in space and build a larger much fractionated spacecraft than the individual modules launched.

Up until now, in-orbit assembly has been restricted to the domain of very large and expensive missions such as space stations. However, we are now entering into a new and exciting era of space exploitation, where new mission applications/markets are on the horizon which will require the ability to assemble large spacecraft in orbit. These missions will need to use much lower cost and innovative technologies and small/micro satellite approaches, in order to be commercially competitive, whilst still being safety compliant. This will enable organisations such as SSTL to compete in an area previously exclusive to large institutional players.

However, in-orbit assembly brings its own challenges in terms of guidance, navigation and control for rendezvous and close proximity operations, robotics, sensors, docking mechanisms, system control, data handling, optical alignment and stability, lighting, as well as many other elements including non-technical issues such as legal and safety constraints. In line with these future mission trends and challenges, and to prepare for future commercial mission demands, SSTL has recently been making rapid strides towards developing its overall capability in "in-orbit assembly in space" using low-cost commercial approaches. This includes studies and collaborations with Surrey Space Centre (SSC) to investigate the three main potential approaches for in-orbit assembly, i.e. deployable structures, robotic assembly and modular rendezvous and docking (including a recently completed funded UKSA NSTP study into low-cost GNC architectures for such missions). Furthermore, SSTL is currently developing an innovative small 20kg nanosatellite (the "Target") as part of the ELSA-d mission which will include various rendezvous and docking demonstrations.

This paper will provide an overview and latest results/status of all these exciting recent in-orbit assembly related activities.