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BUILDING LARGE TELESCOPES IN ORBIT USING SMALL SATELLITES

Abstract

In many types of space mission there is a constant desire for larger and larger instrument apertures, primarily for the purposes of increased resolution or sensitivity. In the Radio Frequency domain, this is currently addressed by antennas that unfold or deploy on-orbit. However, in the optical and infrared domains, this is significantly more challenging, and has up to now either been addressed by simply having large monolithic mirrors (which are fundamentally limited by the volume and mass lifting capacity of any launch vehicle) or by extremely complex and expensive 'semi-folding' designs such as the James Webb Space Telescope. The latter has an aperture of 6.5 m and a total cost of approximately 8 billion US dollars. An alternative is to consider a fractionated instrument which is launched as a collection of individual smaller elements which are then assembled (or self-assemble) once in space, to form a much larger overall instrument. SSTL has been performing early concept development work on such systems, ranging from relatively small proof-of-concept systems for use in Low Earth Orbit (LEO), to much larger systems designed for persistent surveillance or high resolution science observations from high orbits (e.g. Geosynchronous (GEO) orbit or higher). All share the same common characteristics of 1) multiple small elements launched separately and 2) on-orbit assembly to form a larger instrument. For an optical instrument the mirror mass, and cost, typically scales at greater than the second power of the mirror radius, so there are significant advantages to limiting any mirror construction to smaller elements which are then joined to form larger instruments. On ground manufacturing, assembly, and testing cost and complexity is significantly reduced also. However, on-orbit assembly brings its own challenges in terms of Guidance Navigation and Control (GNC), robotics, docking mechanisms, system control and data handling, optical alignment and stability, and many other elements. The paper describes some of the fractionated architecture concepts currently being studied by SSTL, their key technologies and operational concepts, and presents an overview of missions that could be possible in the future.