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SMALL ROBOTS FOR BIG MISSIONS: EXAMINING THE POTENTIAL FOR SMALLSAT-BASED  
DEXTEROUS SERVICING SYSTEMS**Abstract**

Hubble Space Telescope clearly demonstrated the utility of on-orbit satellite servicing. A number of robotic concepts have entered development in recent years to extend servicing beyond the purview of human spaceflight, to applications such as life extension of valuable assets in sun-synchronous or geostationary orbits. Many of these efforts are focusing on the development of robotic on-orbit servicing as a commercial endeavor, in which a maneuvering spacecraft bus with dexterous robotics would be capable of repairing a failed satellite, refueling for mission extensions, or removal to a disposal orbit at end-of-life.

A common element of most commercial concepts for on-orbit servicing is the creation of a large vehicle for servicing with large robotic manipulators. To some degree this is an inevitable outcome of the quest for flight heritage: previously-flown robotic systems were comparatively large (2-3 meters or longer), and maneuvering spacecraft buses were sized based on mission requirements and launch vehicle capabilities. The net result, though, is that the servicing vehicle is of the same scale as the satellites serviced, and launches on a similarly sized vehicle as the client satellite. For that reason the total mission cost of the servicer equals or exceeds that of the client, rendering economic feasibility questionable.

Most programs resolve this issue by assuming that the robotic system will service multiple clients on a single mission, thus increasing award fees and thereby closing the business case. However, the need to be compatible with all potential clients limits each servicing to the “low-hanging fruit” of a simple mission, whether transport of the client to a different orbit or only performing refueling. While potentially profitable, past studies have indicated that 60% of satellite failures require human-level dexterity to resolve, and failure-specific hardware for repairs.

This paper examines various concepts for robotic servicing vehicles based on smallsat technologies. Prototypes have been developed and tested for human-level dexterity in small (80cm) robotic manipulators, capable of mounting on a 100- or 50-kg spacecraft bus. The underlying concept is that the lower procurement and launch costs of a smallsat would allow dedicated servicing missions, closing the business case with a single client. Sample servicing mission concepts are presented, demonstrating basic feasibility. The major challenge is in the logistics train; if the required components for servicing are hundreds or thousands of kilograms, the system must include a highly adaptable orbital maneuvering system to bring the payload to the client vehicle.