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TOWARDS A COST EFFECTIVE IN-ORBIT SERVICING/ADR USING MODULAR AND STANDARIZED APPROACH

Abstract

In-orbit servicing is a concept that appeared decades ago. Nevertheless, with the exceptions of few complex and very costly missions, such as the Hubble space telescope, specifically designed for being serviced in space by astronauts, or space assembly operations such as ISS assembly operations, composed by a mixed of robotics-based assemblies (mainly within the Russian part of the station) and astronauts/EVA supported assemblies (mainly within the US part of the station), in-orbit servicing missions are still lacking of achieving critical mass and due periodicity to become a relevant and significant part of space assets and, hence, a possibility to be seriously taken into account versus designing a new mission or spacecraft to replace old ones. When considering future institutional/commercial in-orbit servicing activities, different types of operational services shall be considered, depending on the orbit (LEO, GTO, GEO, lunar orbits) and on the service type: Active Debris Removal (ADR), Post Mission Disposal (PMD) and On-Orbit Servicing (OOS, including re-fuelling, modules replacement, life extension through control provision). Although the nature of the in-orbit servicing might be very different, from the operations point of view, it can noted that, in all cases, the Servicer S/C will (a) approach and estimate the Client target attitude and tumbling axis (if not controlled); (b) perform rendezvous, including any angular synchronization in presence of, eventually, tumbling target; (c) initial grabbing and/or de-tumbling and/or docking to the Client in a non-intrusive manner and in a way which will not hinder future joint stack operations; (d) provide orbit-control and attitude-control for the joint stack, orbit transfer, and/or deorbit; and (e) provide manipulation capabilities for the different potential required services (e.g. re-fuelling, ORU replacement, assembly operations). The future in-orbit servicing missions shall ensure that providing such services is safe, repeatable over multiple missions and mostly recurrent to keep the costs under profitable boundaries. GMV has worked together with the ESA and international commercial partners over the past two decades in different concepts of missions focusing mostly on Guidance, Navigation and Control technologies and solutions for automated/autonomous operations related to Rendezvous/Docking (ATV-ISS, OTV), Formation Flying (PROBA3), ADR (eDeorbit, ANDROID). All of them could be considered as pivotal applications within the wider in-orbit servicing concept. In this paper, GMV will provide its conceptual (including application examples) approach to use a single, common, cheap, modular and standardized architecture for autonomous GNC subsystem and associated operations for a wide range of in-orbit servicing applications.