SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

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SATELLITE IN-ORBIT SERVICING CONCEPTS

Abstract

Although spacecraft are designed to be highly reliable, a significant number of them fail to complete their full mission successfully. Such spacecraft can sometimes be considered as potentially valuable resources, disabled due to failures in only part of the spacecraft: the rest of the vehicle is fully functional. However, most spacecraft, once launched, are beyond the reach of any further physical intervention; thus a commercial spacecraft with one failed item may have to be written off as an insurance loss. Even those satellites which otherwise successfully complete their mission may be unable to move themselves from their valuable Geostationary orbital slot to a safe disposal orbit. Furthermore, useful lifetime may be limited not only by failures, but also perhaps by resource limitations or even equipment obsolescence in a changing commercial market. It may therefore be envisaged that a method to allow spacecraft to be serviced in orbit could offer significant benefits.

This paper reports on concepts for two in-orbit servicing scenarios. The first scenario involves a servicing vehicle interacting with an existing target spacecraft that has not been designed to be serviced. Here, a space tug vehicle is proposed which can rendezvous with uncooperative target satellites in Geosynchronous orbit, attach itself to the targets, and then re-orbit them. The space tug can also provide a visual inspection capability to assist fault diagnosis and provide lessons learned for future satellite designs.

The second concept presented involves a scenario where both target and servicer have been co-designed, allowing for a greater degree of servicing to be achieved. Here, requirements to enable a Geostationary communications satellite to be designed for serviceability are developed. The servicer is able to rendezvous with a target, inspect it, and supply an appropriate replacement module to allow recovery from equipment failure. It may also provide refuelling if required. Issues such as physical versus functional replacement, and selection of replaceable modules are discussed, and concepts for both target satellite and servicing vehicle are described. The idea of providing satellite manufacturers with a "toolkit" to enable compatibility with a servicing vehicle is proposed.

Finally, the paper also addresses issues of commercial benefits and feasibility. Past failures of commercial spacecraft are investigated, to quantify the potential market and build a rationale for the in-orbit servicing concept. Conclusions are then drawn about barriers and enablers to the deployment of the proposed servicing vehicles.