BIS-RS-2014-_____

MSR IOD Study

Low-Cost End-to-End In Orbit Demonstration of Key Technologies for the MSR Mission

Emanuele Monchieri
Airbus Defence & Space
Gunnels Wood Road, SG1 2 AS, Stevenage, UK; +44 (0)143877 3843
emanuele.monchieri@astrium.eads.net

Benjamin Dobke
Airbus Defence & Space
Gunnels Wood Road, SG1 2 AS, Stevenage, UK; +44 (0)143877 3146
benjamin.dobke@astrium.eads.net

ABSTRACT

The Mars Sample Return (MSR) mission is the number one goal for Mars planetary science and will present a major milestone in the exploration of the solar system. Despite the scientific instrumentation brought to the surface of Mars by previous and planned missions, studying unaltered Martian materials using the huge array of sensitive scientific equipment on Earth may result in a paradigm shift in planetary science, helping to answer questions about the nature of Mars, its formation, and the possibility of life on another planet. Various mission architectures are under consideration, and are evolving. All such mission concepts have a common fundamental requirement - the launch of a sphere - containing the collected soil samples and of the size of a football - into Mars orbit and its retrieval performed by a pre-existing orbiter. This sphere, Sample Container (SC), must be found thousands of kilometres away, approached, and then captured to be further packaged before its return to Earth. This complex sequence of operations must be done almost completely in an autonomous way, due to the typical delay in Earth-Mars communications, and the whole success of the MSR Mission relies on its successful performance. For this reason, this represents a major risk that must be mitigated before the mission actually begins. Previous studies have investigated some of the key aspects relevant to this rendezvous and capturing sequence, but they have also immediately showed the limitations in what can be actually tested/replicated on-ground and/or during parabolic flight/drop tower campaigns.

This paper describes how a low cost In-Orbit Demonstrator (IOD) can be used to validate this mission critical development, and pave the way for future autonomous in-orbit rendezvous missions. The defined mission was aimed at providing a cost efficient demonstration of key technologies such as long range optical detection, autonomous GNC for rendezvous & capture of uncooperative target, capture and securing of the free-flying Sample Container, and on understanding their applications on similar missions, e.g. debris removal.

A clear definition of the main mission objectives and of the associated benefits in terms of risk mitigation and TRL improvement has been derived, together with an overview of the mission architecture and of the full operations concept to be implemented. One of the most critical aspects that has been assessed is to verify the representativeness of a low-cost IOD with respect to the actual Mars Sample Return mission (which will likely be a multi-agency endeavour due to the complexity and overall cost). This has been demonstrated by identifying the main commonalities and differences with the MSR mission and environmental parameters, and how those shall be addressed in order to guarantee useful and reliable results. In support to these analyses, a phase-0 design of the sample capture payload has been performed, including a preliminary selection of potential platforms, launchers, and ground segment strategy, and a preliminary estimation of the main engineering budgets. This allowed demonstrating the feasibility not only from the technical point of view but also by ensuring to implement a low cost mission.

KEYWORDS: In-orbit demonstration, MSR