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Nanoscale landers and instrument carriers: enhancing larger mission's science return by investing in low cost solutions: the MASCOT-1 to X and ROBEX examples

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In December 2014 the Japanese Aerospace Agency (JAXA) has launched its second asteroid sample return mission – the successor of the famous Hayabusa: Hayabusa-II. Onboard is a small landing package equipped with a set of instruments, which has been developed by the German Aerospace Center (DLR) and the french Centre National d'Etudes Spatiales (CNES) as a possibility to enhance the science return of the main mission via ground truthing and scouting capabilities. In a nutshell, the MASCOT lander is an extremely lightweight (around 10 kg), highly integrated mobile small body landing system with onboard autonomy. It was specifically designed to cope with the requirements as imposed by its carrier, its target asteroid (1999 JU3), to which it would be deployed around 2019 and its payload (a camera, a magnetometer, a radiometer and an infrared microscope). After MASCOT has been successfully delivered and for the first time operated in orbit in the last year, now looking a bit into the future, at DLR we are carrying forward the idea of more generic MASCOT variations to be developed for future possible follow-on missions. The focus here is on the advancement of the design from the dedicated lander MASCOT, to a generic instrument carrier, which would be able to deliver a variety of P/L combinations on different mother-missions to different target bodies. This is the so called platform-approach which is getting more and more important in the space systems sector. The paper will describe the approach, how a possible generic platform would look like as well as the most important technological features and how they are realized in a cost-effective manner.
In the same sense and with the same overarching goal of reducing cost for future exploration missions, within the German ROBEX project (Robotic Exploration in Extreme Environments), we are investigating novel methods for robotic exploration ranging from system infrastructural topics to robotics and autonomy. Here, we have developed a modular approach to robotically setting up long-term research infrastructures on the moon that would allow the realization of a multitude of different scientific scenarios with only slight modifications in the systems being used. One of the systems currently under development is a small lightweight instrument carrier. Analogous to the MASCOT lander, it is a self-sustained unit that would travel onboard a larger carrier (e.g. a lunar lander), once having arrived at the final destination, would be deployed – this time robotically – on the surface where it would perform scientific investigations within a pre-defined time frame. In this paper, we will describe the current system design and highlight technologies that enable the modular approach.
The MASCOT and ROBEX experience demonstrate low cost participation in planetary missions by using novel approaches such as platform-development and modularity. Implementing both in a low mass solution requires the usage of lightweight components and subsystems, such as cubesat technology. Pitfalls and challenges about introducing such in a planetary exploration environment will also be discussed in this paper.