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LAUNCH ADAPTER RING CAPTURE TOOL: CANADIAN ROBOTIC TECHNOLOGY FOR THE  
AUTONOMOUS CAPTURE OF UNPREPARED AND NON-OPERATIONAL ORBITAL DEBRIS

**Abstract**

The amount of large orbital debris, from spent upper stages to non-operational satellites, is ever growing, and it is becoming a real threat to the economic viability of high-value orbits. Satellites need to perform ever-increasing numbers of collision avoidance maneuvers, and the risk of a collision is increasing.

Space Agencies are now working on technologies and developing missions to address the threat through Active Debris Removal (ADR). With the wide variety of objects that currently populate the orbital debris environment, one of the key challenges facing these missions is determining exactly how to safely grasp and apply the necessary forces to a target in order to relocate it into a graveyard or atmospheric re-entry orbit. In general, methods proposed in ADR missions have included rigid capture approaches using a robotic arms or appendages, and flexible approaches using tethers, harpoons, or nets. While each approach has its respective merits, the use of a robotic arm provides the benefit of controllability due to its ability to achieve a rigid link between the target debris and the servicing spacecraft after capture.

While Canada has been a world leader in robotic technology capable of performing the capture of spacecraft for three decades, through the highly successful Canadarm, International Space Station, and DARPA Orbital Express mission robotics, to date robotic free-flyer captures in space have only been achieved on “prepared” spacecraft. A prepared spacecraft is one that has been designed to aid and simplify robotic tasks by including features such as a grapple fixture that can be captured by a robotic arm. Since none of the orbital debris threatening the operational on-orbit assets have been designed with on-orbit capture or servicing in mind, their robotic capture must be achieved using a structural feature naturally available on the targets, such as the Launch Adapter Ring.

This paper presents an overview of MDA’s Launch Adapter Ring Capture Tool. Designed and built through the support of the Canadian Space Agency, it is a purpose built robotic tool designed to provide the key technology necessary to address the challenges associated with autonomously grasping an unprepared and uncooperative spacecraft with a robotic arm. The paper justifies the need for the technology, outlines the key driving requirements, provides the concept of operations for its application, and summarizes the integrated testing performed to validate and demonstrate the design of MDA’s TRL-5 engineering development unit and its applicability to upcoming servicing missions.