CANADIAN EXPLORATION PROTOTYPES – BUILDING TOWARDS A FLIGHT MISSION

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In 2010, the Canadian Space Agency (CSA) commenced a large program of exploration prototype developments geared towards rapid technology advancement, community development and international collaboration in preparation for future flight missions to the Moon and Mars. The Exploration Surface Mobility (ESM) initiative funded the development of an architecture with a central focus on surface mobility, including rovers, advanced technology payloads and science instruments. This paper focuses on three of these rovers, three technology payloads and three science instruments developed under ESM.

The Mars Exploration Science Rover (MESR) is a small-class, highly-terrainable Mars rover system primarily supporting autonomous science prospecting and in situ geological analysis. MESR supports a Mars-representative command scheme, providing a mission scripting language and telemetry prioritization for use under limited communication windows and bandwidth constraints. The Lunar Exploration Light Rover (LELR) is a rugged, medium-class lunar mobility platform designed for science, prospecting, surveying and early in situ resource (ISRU) activities, with full upgradability to short distance crew transport. LELR supports teleoperation and fully autonomous modes for simulation of a range of exploration architectures – including ground control and telepresence, e.g. from an orbital outpost. The SL-Commander Rover (SLC) is an electric side-by-side all-terrain vehicle capable of carrying two onboard passengers. SLC is intended to enable EVA-astronaut analogue missions as well as perform autonomous, tele-operated and convoy-style driving. All vehicles support a wide range of payloads via standardized interfaces.

The Next Generation Communications System (NGCS) establishes the communications infrastructure required to operate a planetary mission including links for base-rover, base-astronaut and rover-microrover communication. The Next Generation Vision System (NGVS) combines a high resolution lidar with a zoom camera and multi-spectral imager to provide excellent situational awareness and remote science assessment capabilities. The Next Generation Power System (NGPS) provides a high-energy fuel cell based range extending capability to analogue vehicles. The Three-Dimensional

Exploration Multi-spectral Microscopic Imager (TEMMI) instrument combines 3D topographic mapping with multispectral high-resolution imaging. The Lunar Ground Penetrating Radar (LGPR) enables survey and prospecting in the shallow subsurface region, supporting future lunar resource characterization. The Raman Sensor for the Identification of Carbon (RSIC) instrument is a stand-off, deck or mast mounted laser-based analytical sensor for astrobiological research.

An exciting component of the ESM program has been the collaboration between a large number of key Canadian stakeholders. Industry examples include Bombardier Recreational Products Centre for Advanced Technology, Optech and Hydrogenics. Academic examples include the University of Toronto Institute for Aerospace Studies (UTIAS) Space Flight Lab and Autonomous Space Robotics Lab as well as the National Optics Institute (INO) in technology elements, and a variety of academic partners from the Canadian space science community. This community development is essential to Canadian preparation for national-scale contributions to future flight missions.

With most systems already delivered to CSA and more nearing completion, the ESM fleet of vehicles, technology demonstration payloads and science instruments are now ready for near-term use in analogue environments as part of both Canadian and international deployments, where they will support science, technology, operations, and partnership preparations ahead of the next decade of space exploration.