

MEETING THE CHALLENGE OF AFFORDABLE LUNAR EXPLORATION – HERITAGE SYSTEMS, FLEXIBLE PARTNERSHIPS, NEW FLIGHT OPPORTUNITIES.

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Introduction: While lunar exploration has enjoyed turbulent times for almost a decade - politics and economics driving multiple resets to international mission plans - the lunar community remains doggedly optimistic and with somewhat good cause. Scientific evidence continues to build for the Moon's value-proposition within a sustainable exploration architecture while multiple assessments of alternate Flexible Path destinations conclude the Moon to be among the more affordable next steps. International support is increasing rather than receding for lunar science and prospecting, while increasingly viable candidates from the private sector are slowly emerging with newly-tuned business models that reflect the post-financial crisis landscape. In contrast to the Constellation era the lunar community is now more acclimatized to the current economic conditions and there is widespread recognition that the scale, scope and ambition of near-term missions and technology development must be tailored accordingly.

At the same time the exploration frontier continues to push outwards and system performance envelopes continue to be pushed as future missions are tasked to go farther, into harsher environments all while being more efficient with limited spacecraft resources.

In this context it is well acknowledged that new approaches are required, and hence there exists an increased openness between international partners, an increased desire for public-private and terrestrial partnerships and an increased need to leverage developed capabilities alongside development of new in missions.

This presentation focuses on the near-term lunar prospecting context and considers three examples of industrial efforts at compelling, flexible and/or innovative approaches to help achieve more affordable lunar science and exploration missions.

Adaptation of Heritage Technology: MDA has provided robotics within international space exploration for over three decades across human and robotic spaceflight – from Shuttle and ISS assembly to Satellite Servicing Demo Missions, and more recently robotics and science instrumentation on each of the last 4 international Mars surface missions for both NASA and the CSA. MDA is currently building a CSA laser mapping sensor for NASA's OSIRIS-Rex asteroid mission and the Rover Mobility subsystem elements for ESA's ExoMars Rover in 2018. MDA recently conducted a 2013 study for CSA examining the flight

concept of a candidate CSA contribution to NASA's Resource Prospecting Mission concept.

SSL, the Paolo-Alto based US commercial satellite manufacturer, has successfully flown over 150 spacecraft bus platforms and is a trusted provider of communications satellites worldwide. Most recently in space exploration SSL delivered elements of NASA's LADEE orbiter propulsion system based on a heritage design from its commercial spacecraft platform. This presentation will provide an update on several other emerging technologies that are being adapted from heritage systems for polar and far-side lunar surface science, prospecting and exploration:

- Lunar Resource Prospecting rover
- Autonomous navigation & teleoperation
- Lunar ISRU and sample return robotics
- Vision and lunar science instrumentation
- Lunar communications
- Lunar orbiter propulsion system

Flexible partnership models for lunar planning:

International cooperation is an increasingly crucial element within space exploration. On the one hand it can provide dramatic leverage in terms of mission potential, while on the other hand it can introduce a number of sensitive programmatic considerations that must be handled carefully to maintain net positive benefit. Discussion is given to the topic of international cooperation from the perspective of industry with both a US and international presence and examples of the flexibility and risk reduction this currently provides for lunar exploration.

New Lunar Flight Opportunities: SSL is an established provider of hosted-payload opportunities aboard its commercial satellites. A short overview is provided of the hosted-payload potential aboard SSL satellites with multiple launches each year, and the potential for small lunar science and exploration payloads that either reside on the host spacecraft or are ejected for subsequent transit to the Moon.