National Aeronautics and Space Administration

On-orbit Servicing Assembly and Manufacturing (OSAM)

Technology Transfer Workshop

Journeying Longer and Seeing Farther

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Lightweight Surface Manipulation System (LSMS) Technology Transfer Overview

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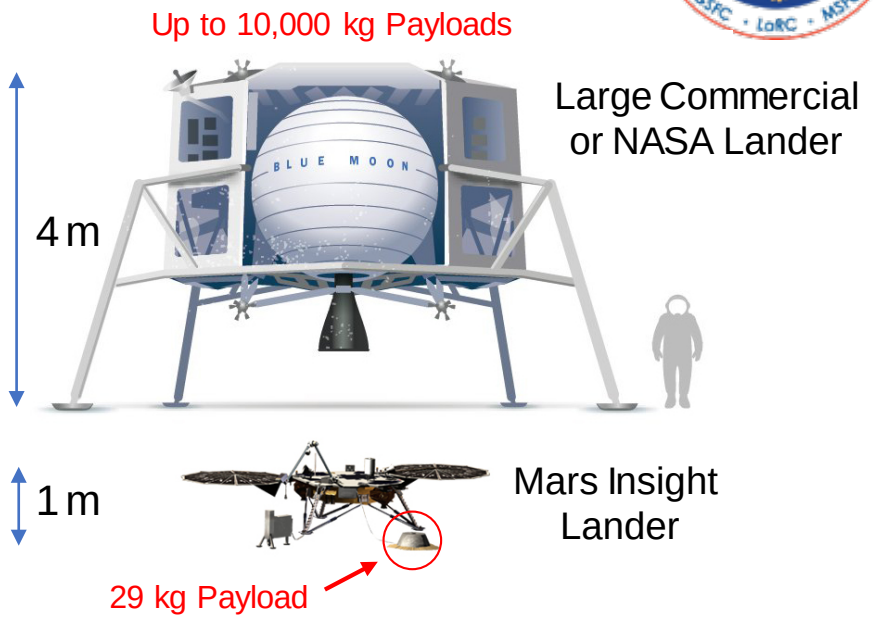
Lightweight Surface Manipulation System (LSMS) - Overview

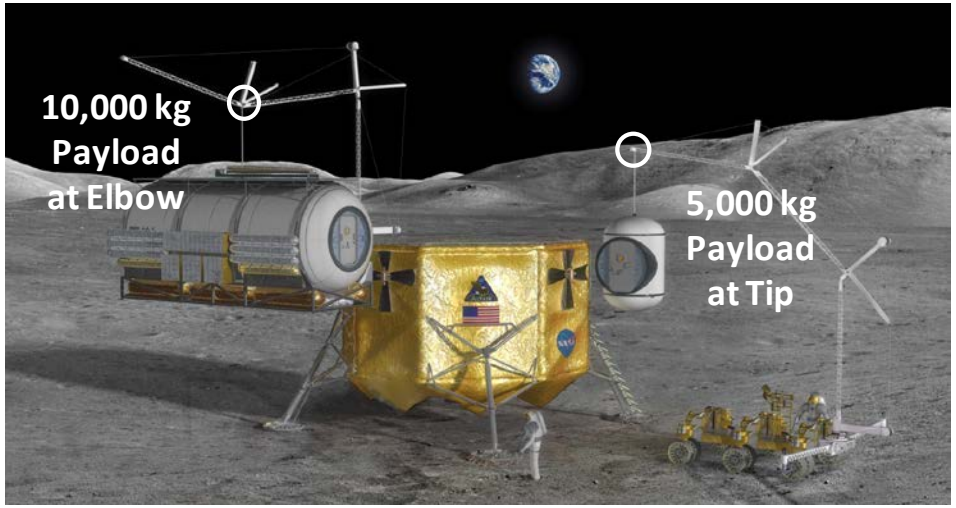
The Problem: NASA and commercial landers require a robust approach to offloading and maneuvering payloads in a wide range of masses, sizes, and shapes.

State of the Art: Planetary-surface serial manipulators do not scale to heavy payloads.

- Payload mass and size, reach required, and height and size of lander, are all significantly greater for large commercial and NASA landers.

The Solution: A lightweight, scalable and versatile, long-reach manipulator that combines the structural efficiency and robustness of commercial cranes, with the enhanced dexterity and multi-functionality of a deployable robotic arm.





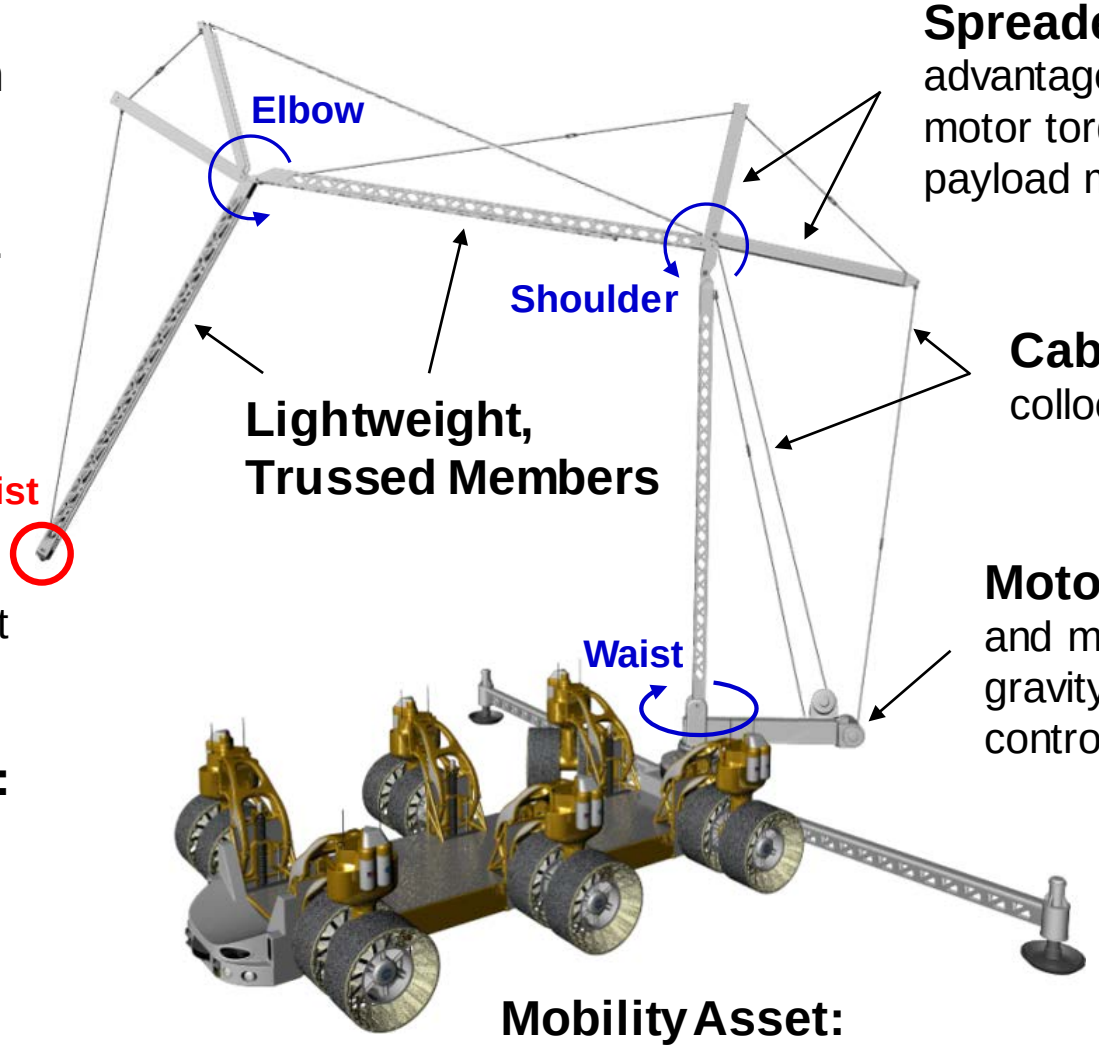
LSMS: Lightweight, Robust, and Reusable

Highly Structurally Efficient Tension-Compression Design

- Uses commercial crane safety factors standards.
- Greater operational flexibility (i.e. improvised / unplanned uses)

Quick-Change Interfaces: Mechanical / power / data connections at tip and base.

Custom End-Effectors: To add additional functions or capabilities.



Spreaders: Provide high mechanical advantage at the joints, reducing required motor torque and power for given reach / payload mass.

Cables: Allows joint actuation via non-collocated motors at the base.

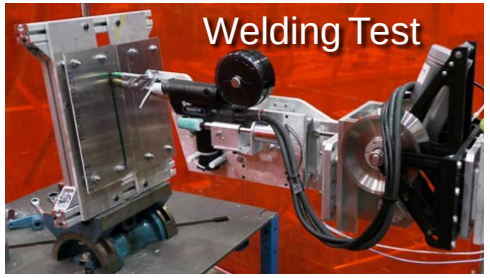
Motors/gearboxes: Easily accessible and maintainable, lowers the center of gravity, and allows easier thermal and dust control of the primary electronic systems.

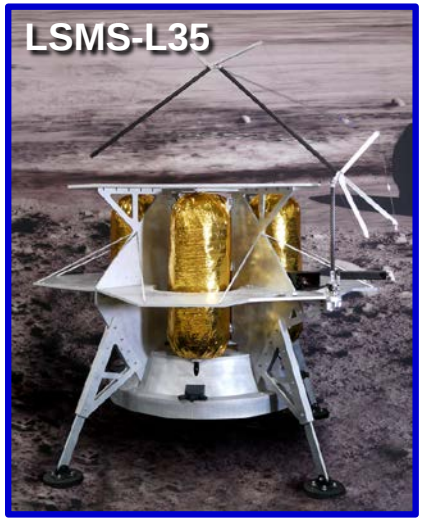
Mobility Asset: Allows reuse and repositioning.

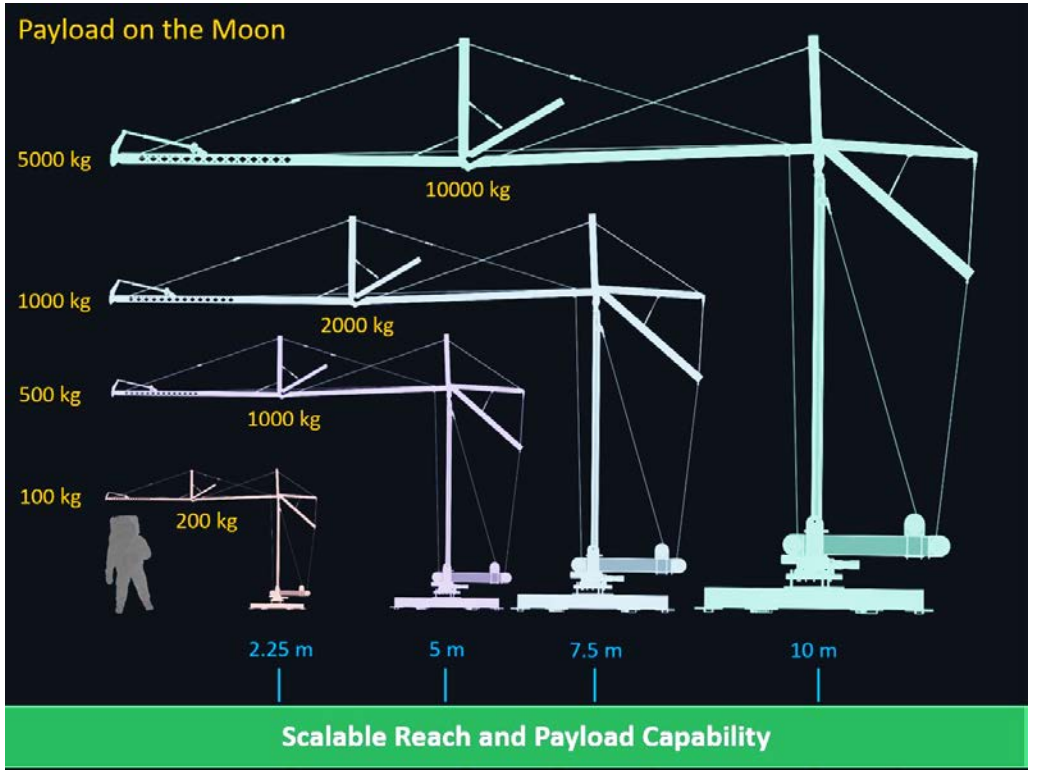
LSMS: Scalable and Easily Adaptable Architecture

Architecture is easily scalable to a wide range of reach and tip mass requirements.

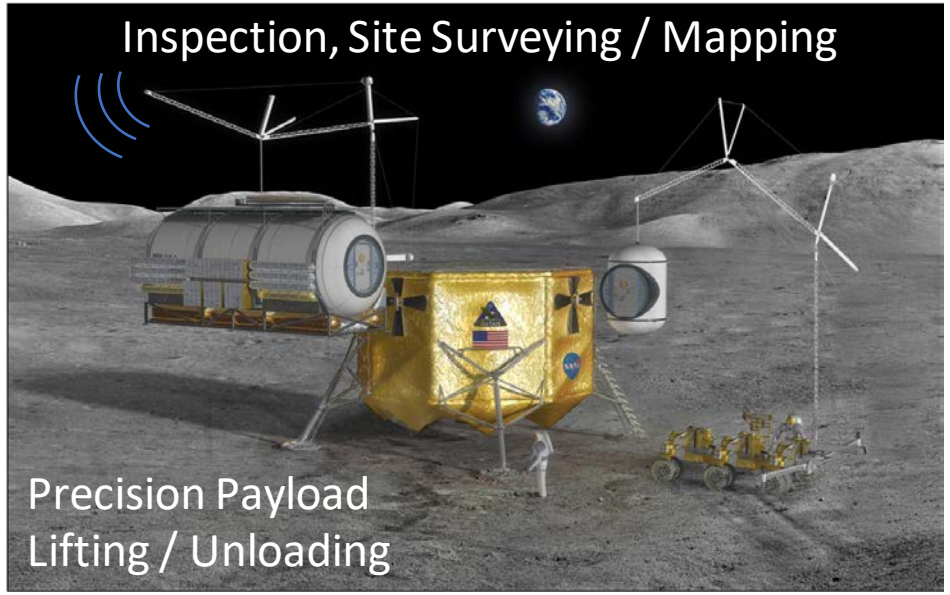
- 12 years of design heritage and testing in 1000 kg (lunar) tip mass capable prototype unit.
- Recently built mini-LSMS prototype demonstrates scalability to smaller commercial landers.
- New 3-year NASA LSMS program (2021 to 2023), is developing a 5000-kg tip payload variant for large commercial and human landers, to be flown as a tech demonstrator in the mid-2020s.

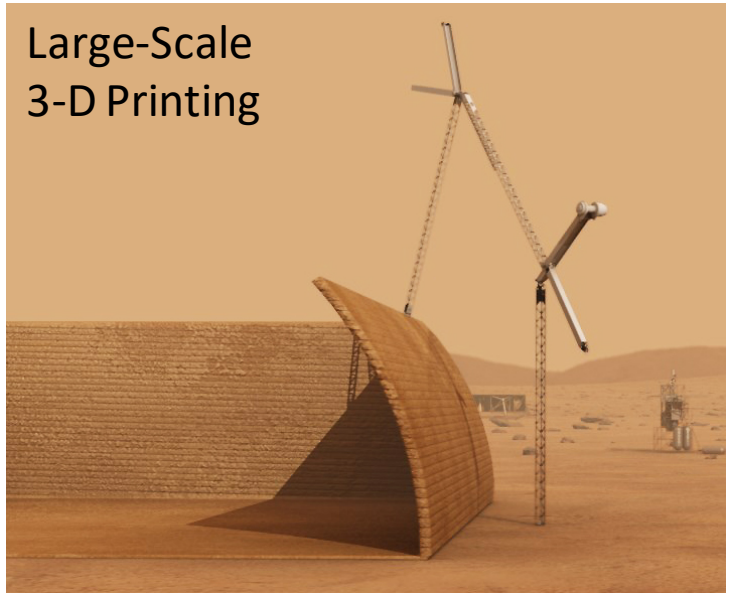


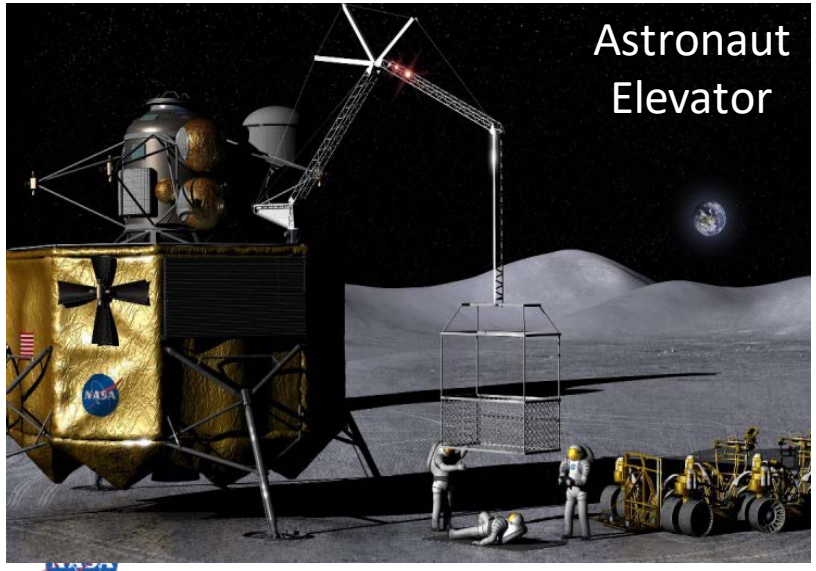


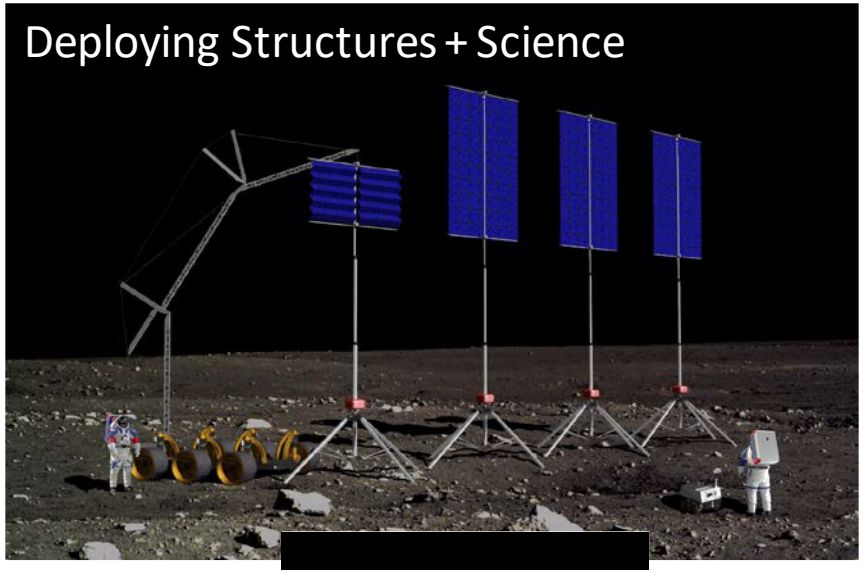


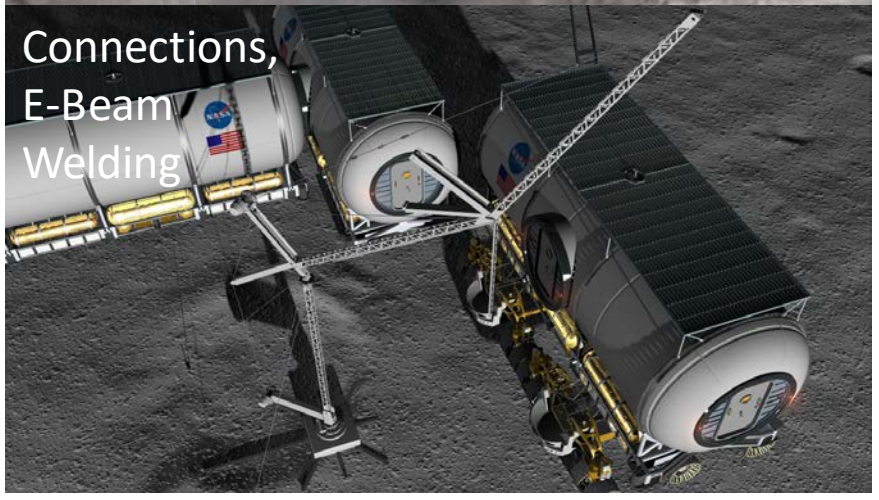
LSMS: Versatile and Multi-Functional











LSMS: Collaboration and Tech Transfer Opportunities

Benefit and Value:

- Provides core offloading and manipulator capability on the lunar surface while also efficiently enabling multiple additional services for NASA and industry.
- Reduces the need for developing purpose-built hardware to perform additional critical functions on the surface; task-specific tools are quicker and less costly to develop and implement.
- Rapid path to commercialization, cost-sharing, and reduced per-unit cost via commercial partnerships.
- Inexpensive to replicate the device once flight proven.

Opportunity:

- High interest and support of LSMS at NASA. 3-year funded program to take LSMS-5000 to proto-flight unit to be integrated on commercial or NASA technology demonstration flight.
- Provide needs and requirements from industry for desired capabilities and services.

Partnerships:

- Commercial customers who need core manipulator or are developing tools that could use the LSMS.
- NASA leverages internal work on complimentary technologies: bulk metallic glass “cold” gearbox (JPL), autonomy (ARC and LaRC), in-situ resource use support (KSC), and dust mitigation (LaRC and JSC).
- Leverage academia: universities involved in lunar technology development, and high school competition (Virginia Space Grant Consortium).

NASA Centers:	ARC – Ames Research Center	JPL – Jet Propulsion Laboratory
JSC – Johnson Space Center	KSC – Kennedy Space Center	LaRC – Langley Research Center

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Robots are poised to make what was once thought to be impossible in space a reality. From extending the lifespan of satellites, to assembling massive life-seeking telescopes in space, to refueling and repairing spacecraft on journeys to distant locations, the possibilities are endless. Key to these endeavors is demonstrating the foundational capabilities – servicing, assembly, and manufacturing.

To arrange further discussion of on-orbit servicing technologies contact Patrick Cosgrove (Patrick.a.cosgrove@nasa.gov)

Background Graphic: OSAM technologies continue the legacy of the Hubble Space Telescope (HST) Servicing Missions, and will be implemented to assist astronauts span and expand orbiting stations like the International Space Station (ISS). OSAM technologies will also support lunar surface and orbiting operations.