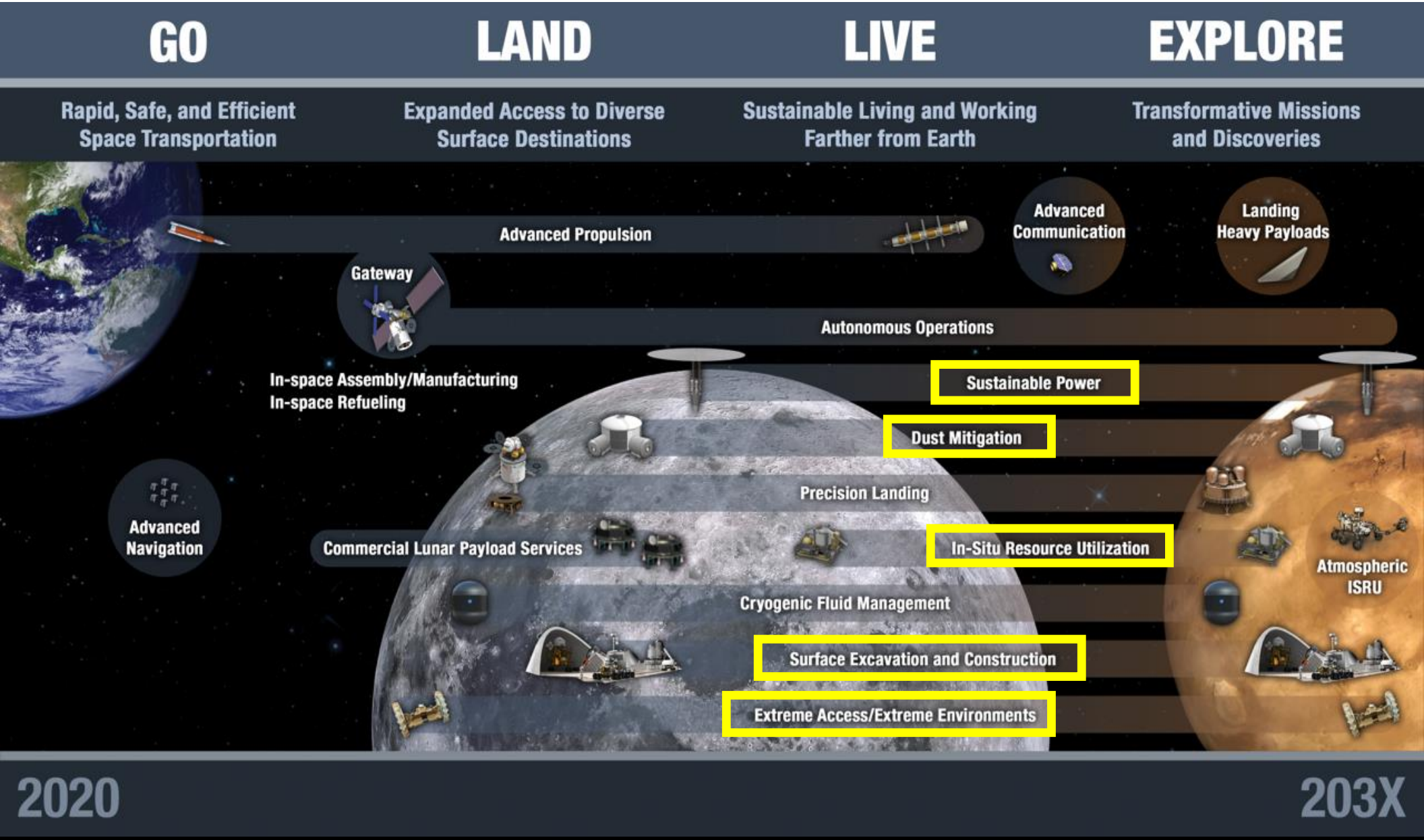


Overview of NASA's Moon-to-Mars Planetary Autonomous Construction Technology (MMPACT) Project

R. G. Clinton, Jr., PI, Jennifer Edmunson, Mike Fiske, Mike Effinger, Jason Ballard, Evan Jensen

Planetary & Terrestrial Mining Sciences Symposium
June 10, 2021

Lunar Surface Innovation Initiative (LSII)
Strategic Technology Investments



Moon-to Mars Planetary Autonomous Construction Technologies (MMPACT) Overview

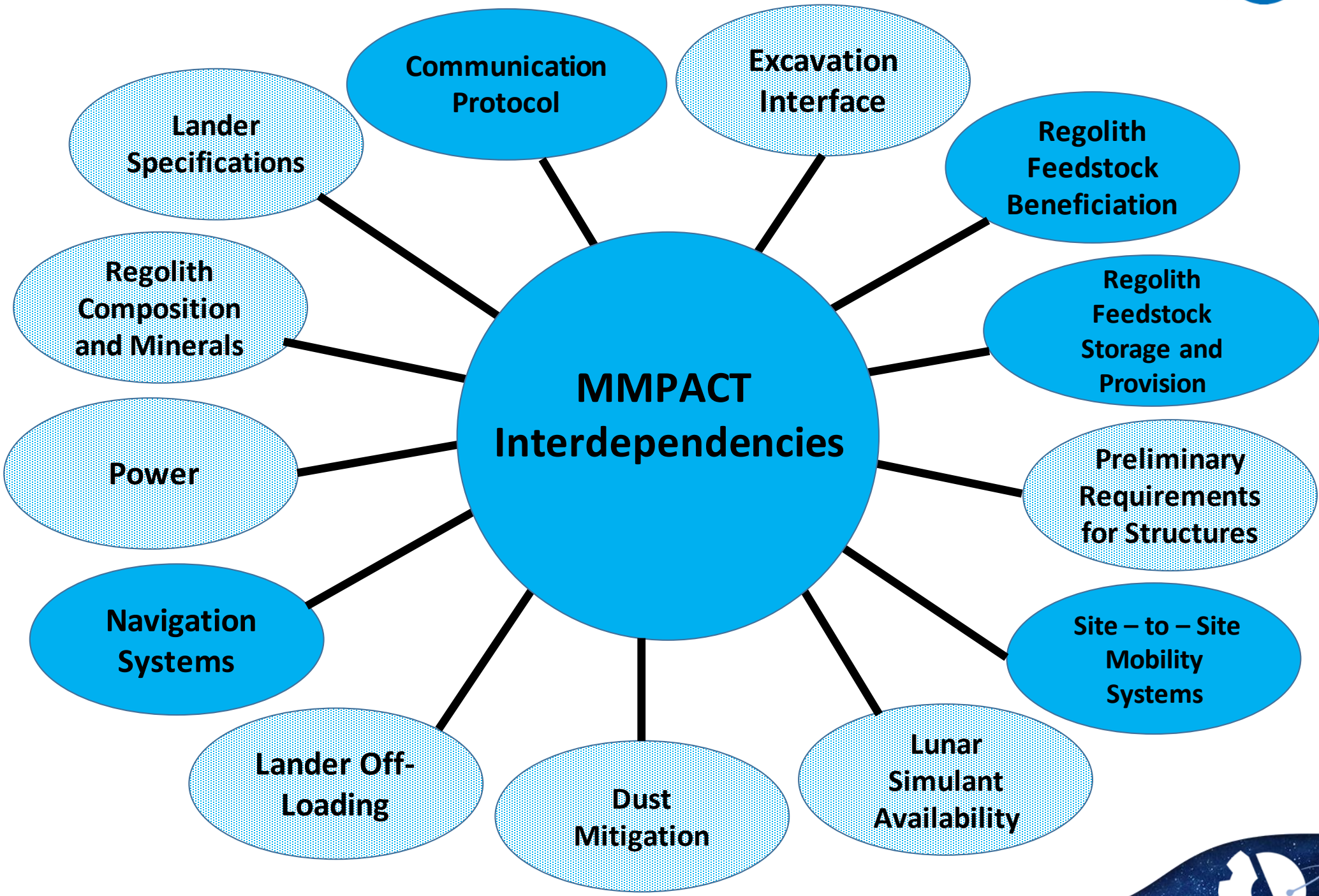
GOAL

Develop, deliver, and demonstrate on-demand capabilities to protect astronauts and create infrastructure on the lunar surface via construction of landing pads, habitats, shelters, roadways, berms and blast shields using lunar regolith-based materials.

APPROACH

- MMPACT is comprised of 3 interrelated elements
  - Olympus – Autonomous Construction System
  - Construction Feedstock Materials Development
  - Microwave Structure Construction Capability (MSCC)
- High Level Capability Gaps (including those identified by the LSII Formulation Guidance for Lunar Surface Construction):
  - Deposition processes and associated materials
  - Increased autonomy of operations
  - Hardware operation and manufacturing under lunar environmental conditions
  - Long-duration operation of mechanisms and parts
  - Scale of construction activities
  - Material and construction requirements and standards

MMPACT Interdependencies



Architectural Concept Designs for Lunar Landing Pads and Habitats

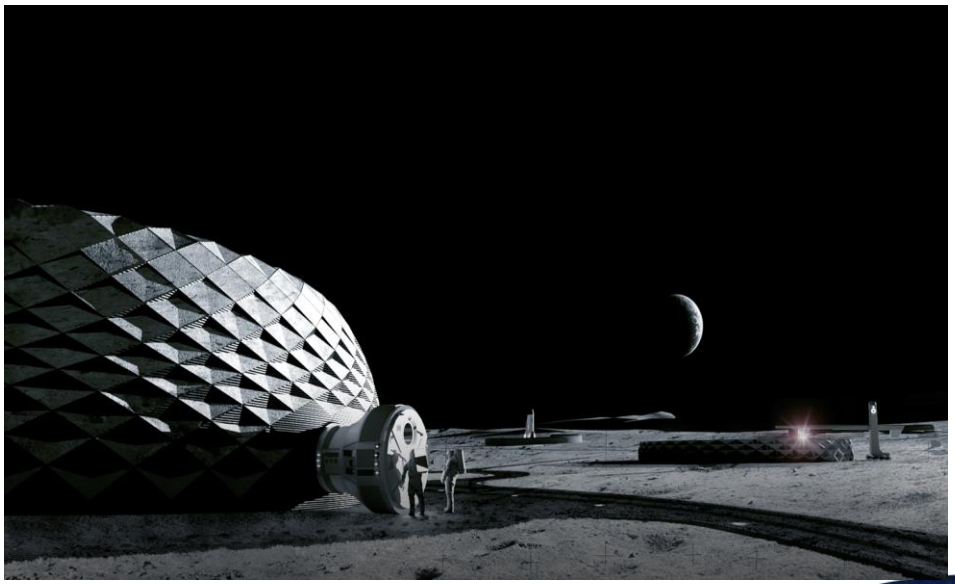
- **ICON engaged leading architectural firms to develop preliminary concepts for both Landing Pads and Habitats to inform engineering decisions for Olympus construction hardware design and development**

- Space Exploration Architecture (SEArch+)
  - Landing Pad Concepts (primarily)
  - Design winners in two phases of NASA's Centennial Challenge for a 3D-Printed Habitat.
- Design Concept 100% Complete

- Bjarke Ingels Group (BIG)
  - Habitat Concepts (primarily)
  - UAE Mars Science City Design, Google Headquarters, 2 World Trade Center, Lego House…
- Design Concept 100% Complete

- **Concept design summaries were presented to NASA Space Technology Mission Directorate Leadership, and Principal Technologists in early December**





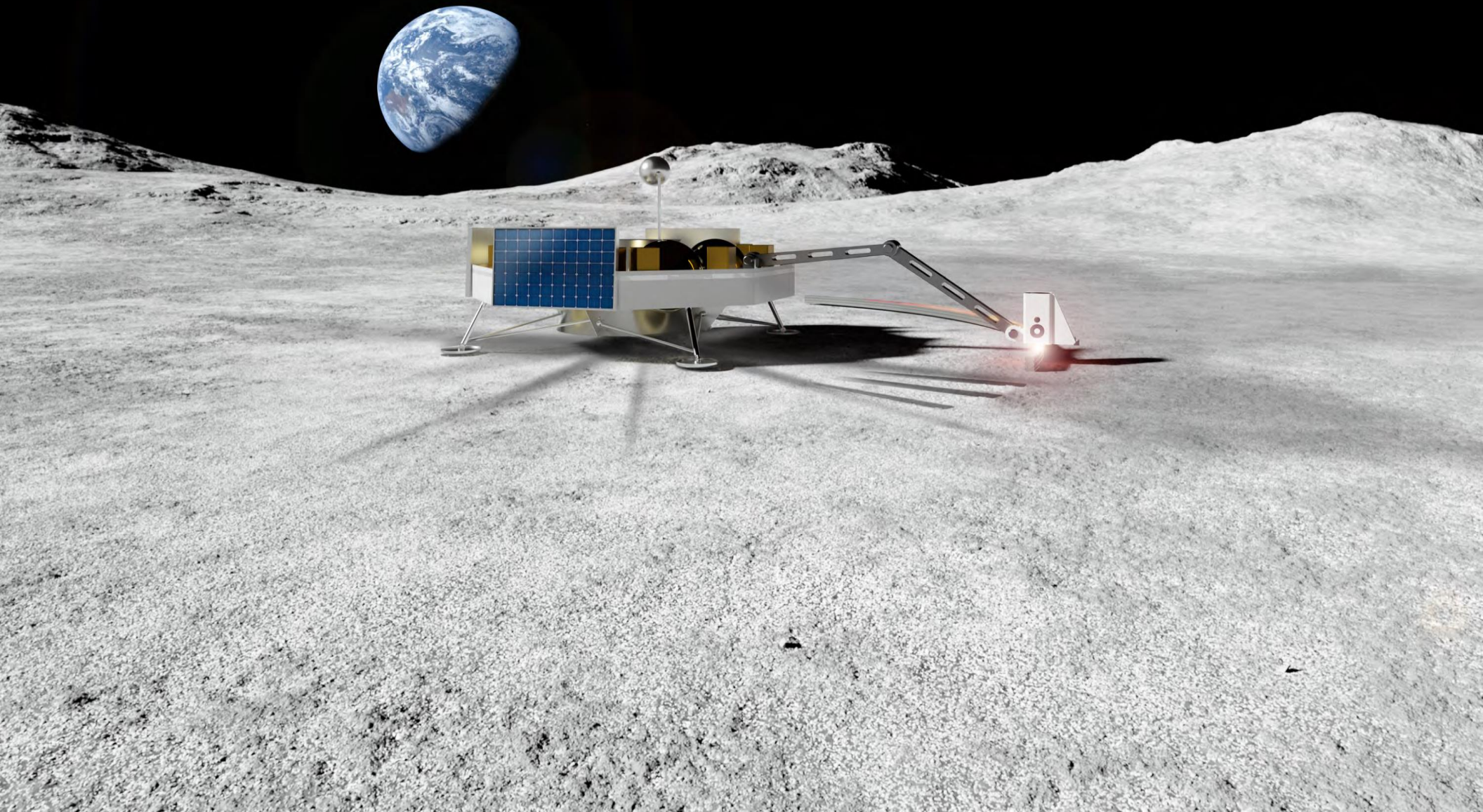
Demonstration Mission -1 (DM-1) Objective A: Demonstrate Viable ISRU-based Structural Capabilities



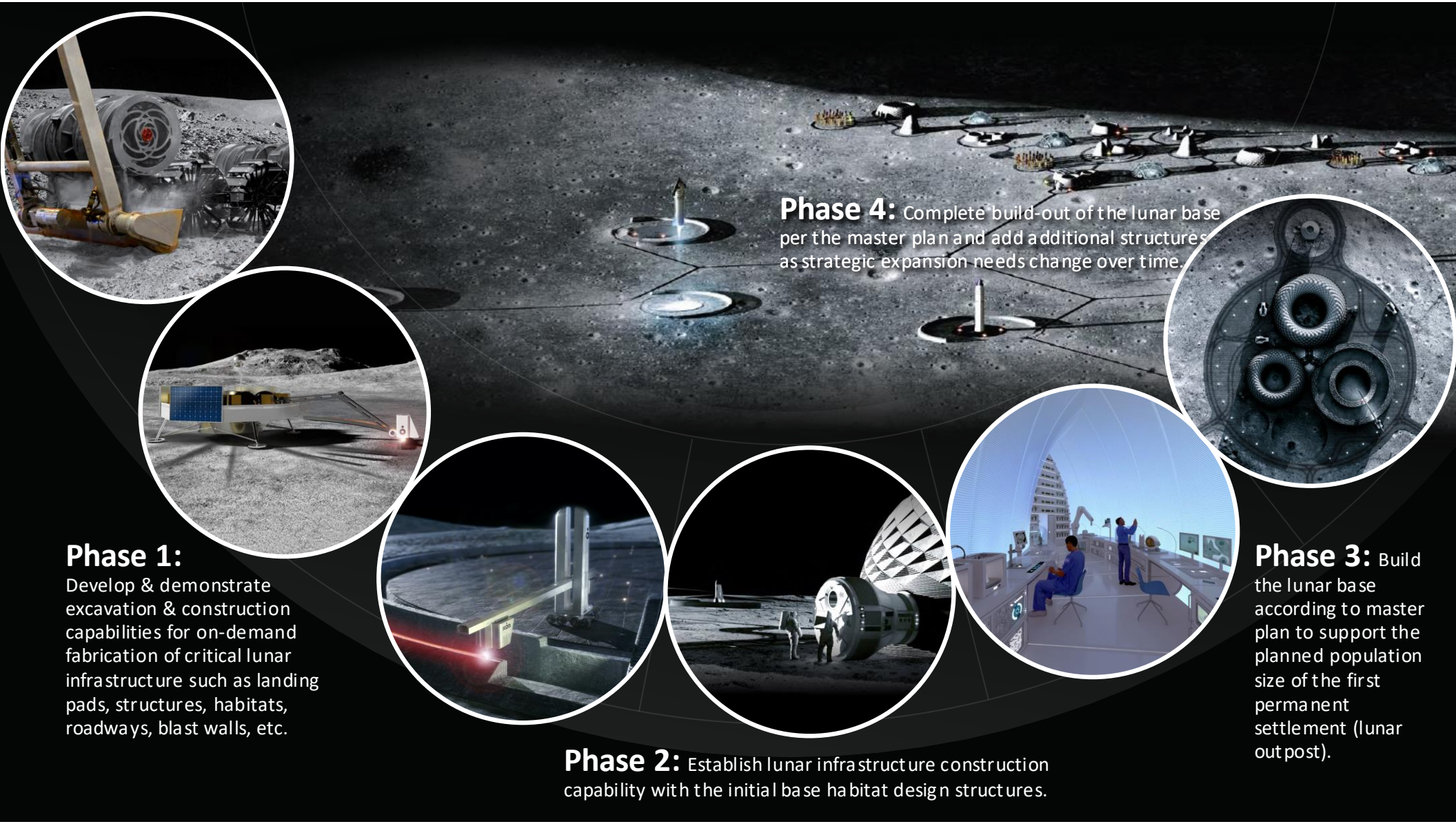
- In order to thrive on the lunar surface, we must "***live off the land***".
- Is it possible to work with what we have on the lunar surface?
- ***Our primary objective is to create structural components while minimizing the amount of materials brought from Earth.***

MMPACT Preliminary Concept DM-1

A demonstration mission that serves as a proof of concept for newly developed ISRU additive construction technology.



Lunar Construction Capability Development Roadmap



Phase 1: Develop & demonstrate excavation & construction capabilities for on-demand fabrication of critical lunar infrastructure such as landing pads, structures, habitats, roadways, blast walls, etc.

Phase 2: Establish lunar infrastructure construction capability with the initial base habitat design structures.

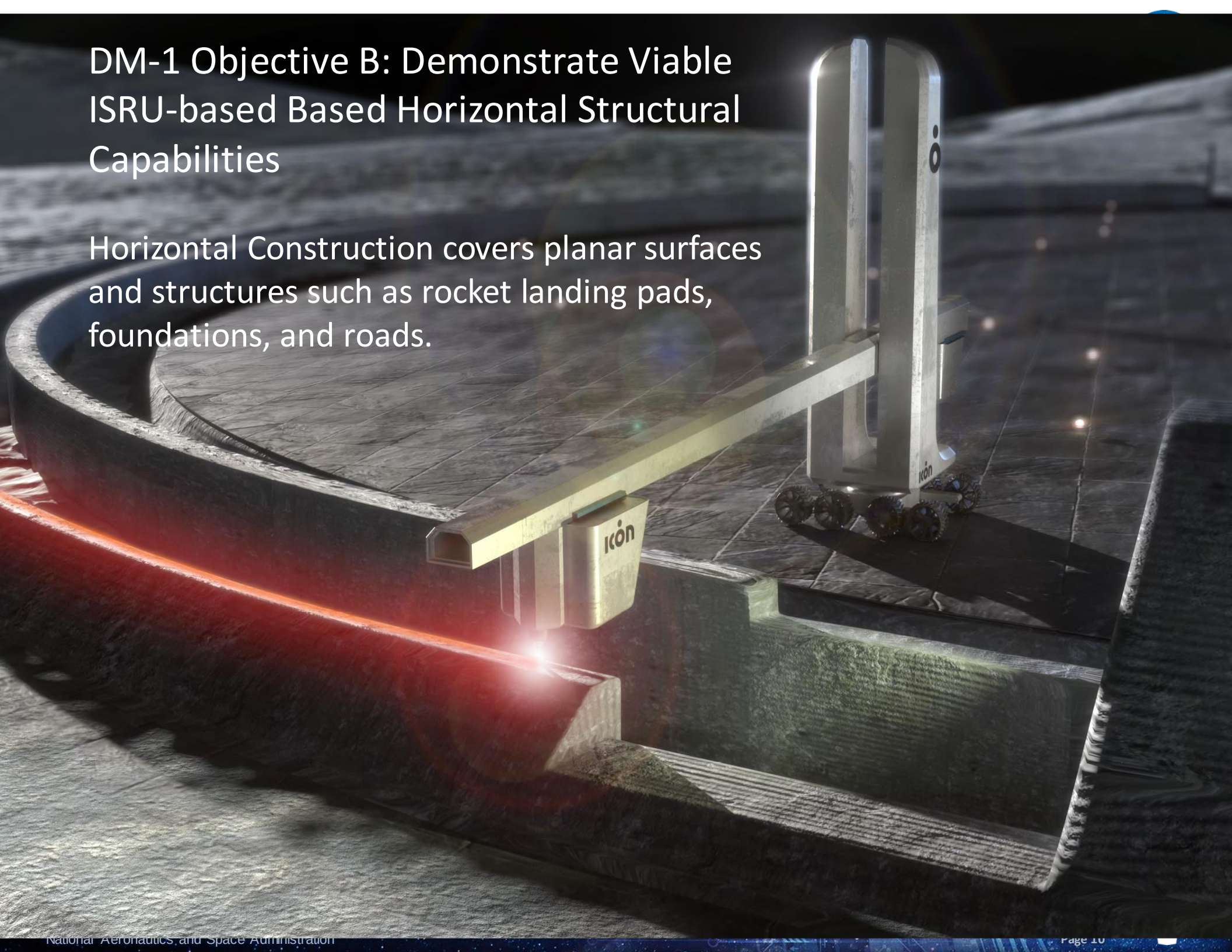
Phase 3: Build the lunar base according to master plan to support the planned population size of the first permanent settlement (lunar outpost).

Phase 4: Complete build-out of the lunar base per the master plan and add additional structures as strategic expansion needs change over time.


NASA
Technology Drives Exploration

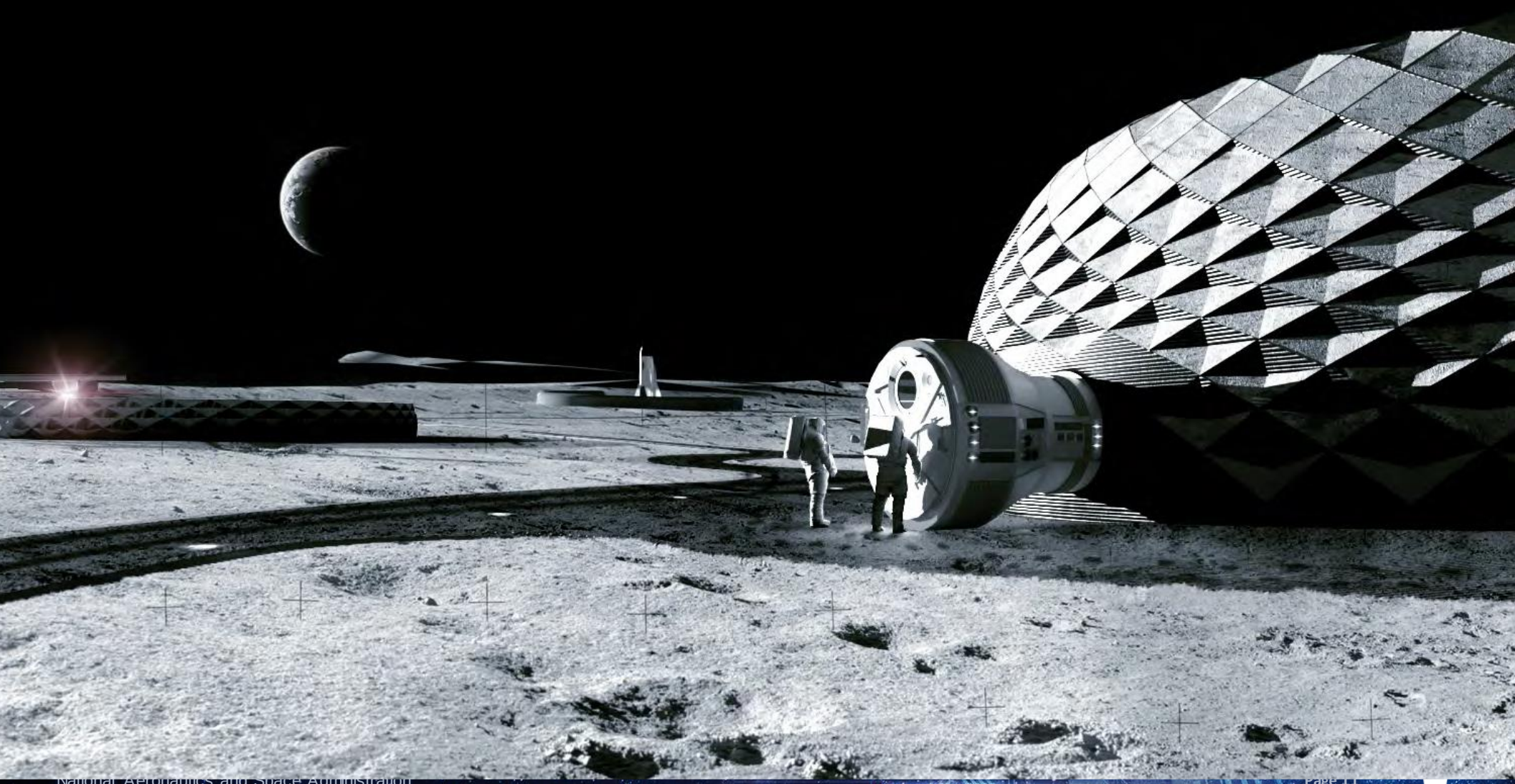
DM-1 Objective B: Demonstrate Viable ISRU-based Based Horizontal Structural Capabilities

Horizontal Construction covers planar surfaces and structures such as rocket landing pads, foundations, and roads.



DM-1 Objective C: Demonstrate Viable ISRU-based Based Vertical Structural Capabilities

Vertical Construction covers volumetric structures such as habitats, garages, and protective berms.



Alternate Construction Concept for LSH

- ICON has demonstrated segmented (print and lift) construction for a garage/shelter for the Marine Corps at Camp Pendleton
  - Segments printed in horizontal configuration
  - Printed segments are lifted and assembled in the vertical with crane





- Same print and lift construction method is being utilized by ICON/BIG for the CHAPEA Mars Analog Habitat being constructed at JSC.

- Could similar approach be considered for construction of the LSH using MMPACT and LSMS?

