

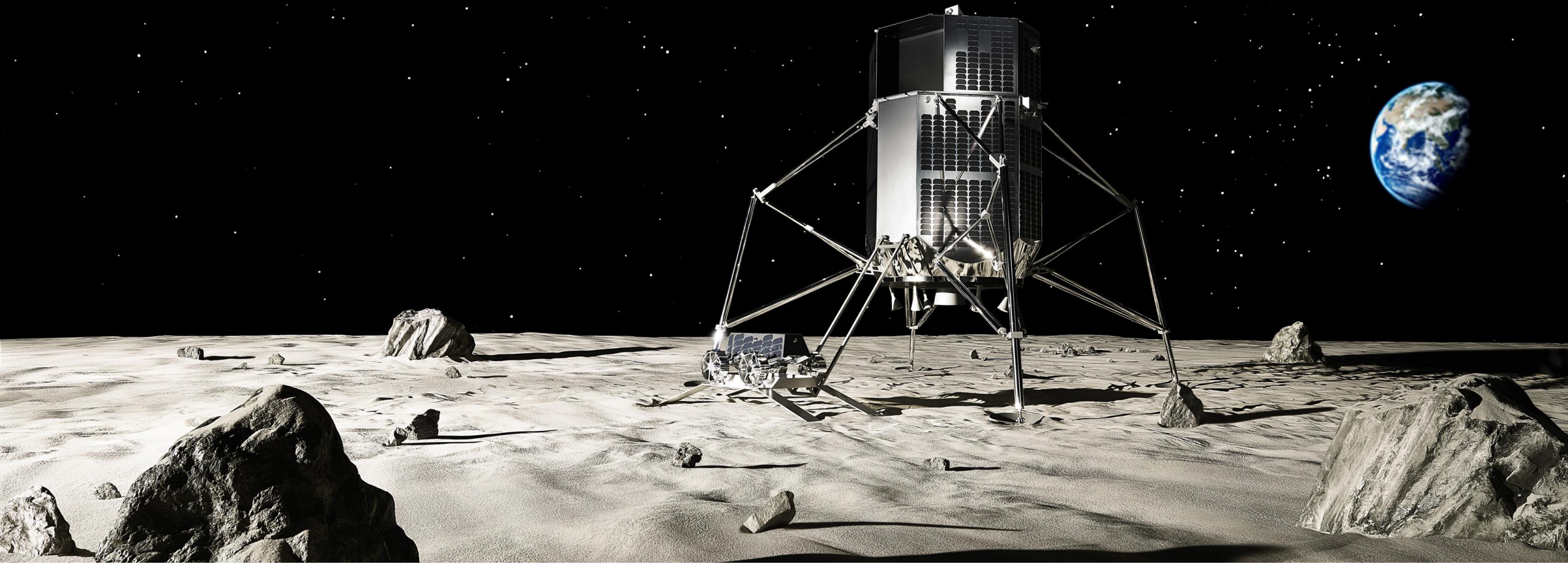
【講演スライド | BMA2019 秋季大会 | 2019 年 12 月 1 日】



袴田武史氏

i s p a c e

宇宙を人類の生活圏に
～史上初の民間月面探査への挑戦～





Takeshi Hakamada

Founder & CEO, ispace

2004 — Aerospace Engineering B.S., Nagoya University

2006 — Aerospace Engineering M.S., Georgia Institute of Technology

2006 ~ 2013 — Consultant/Project Leader, Lowendal Group

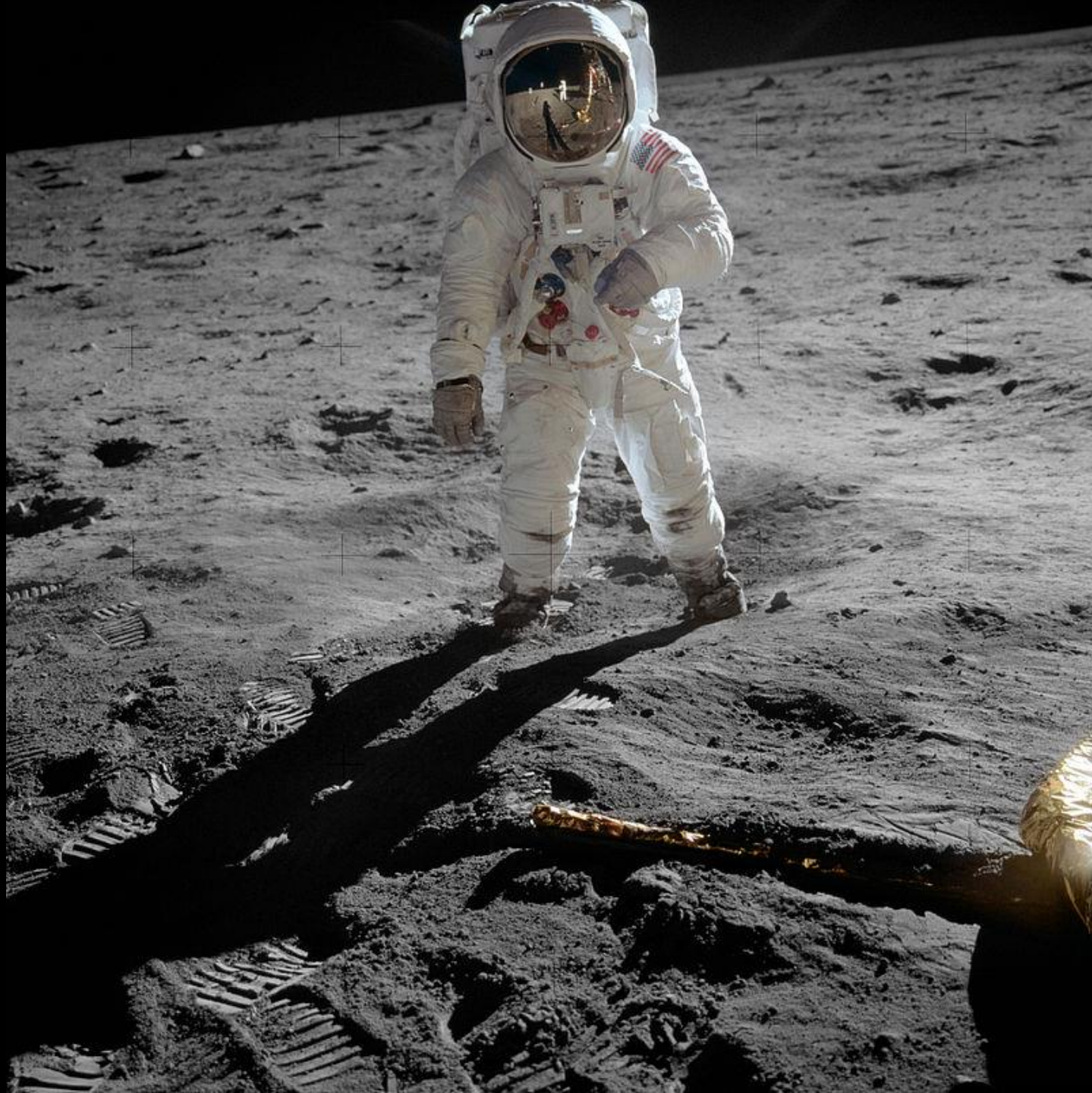
2010 – 2013 — CEO, White Label Space Japan

2013 – Present — Founder & CEO, ispace

Apollo 11 Mission (Jul 20, 1969)

"one small step for man, one giant leap for mankind"

Neil Armstrong and Buzz Aldrin
achieved the first manned landing
on the Moon



Apo 50
NEXT GIANT LEAP

The logo is set against a dark blue space background with stars and nebulae. The word 'Apo' is in a large, white, stylized font. The 'O' in 'Apo' contains a detailed image of the Moon, and the 'o' in '50' contains a detailed image of the planet Mars. A white swoosh line passes through the middle of the 'Apo' and '50'. The number '50' is positioned below 'Apo'. The words 'NEXT GIANT LEAP' are written in a smaller, white, sans-serif font to the right of the '50'.



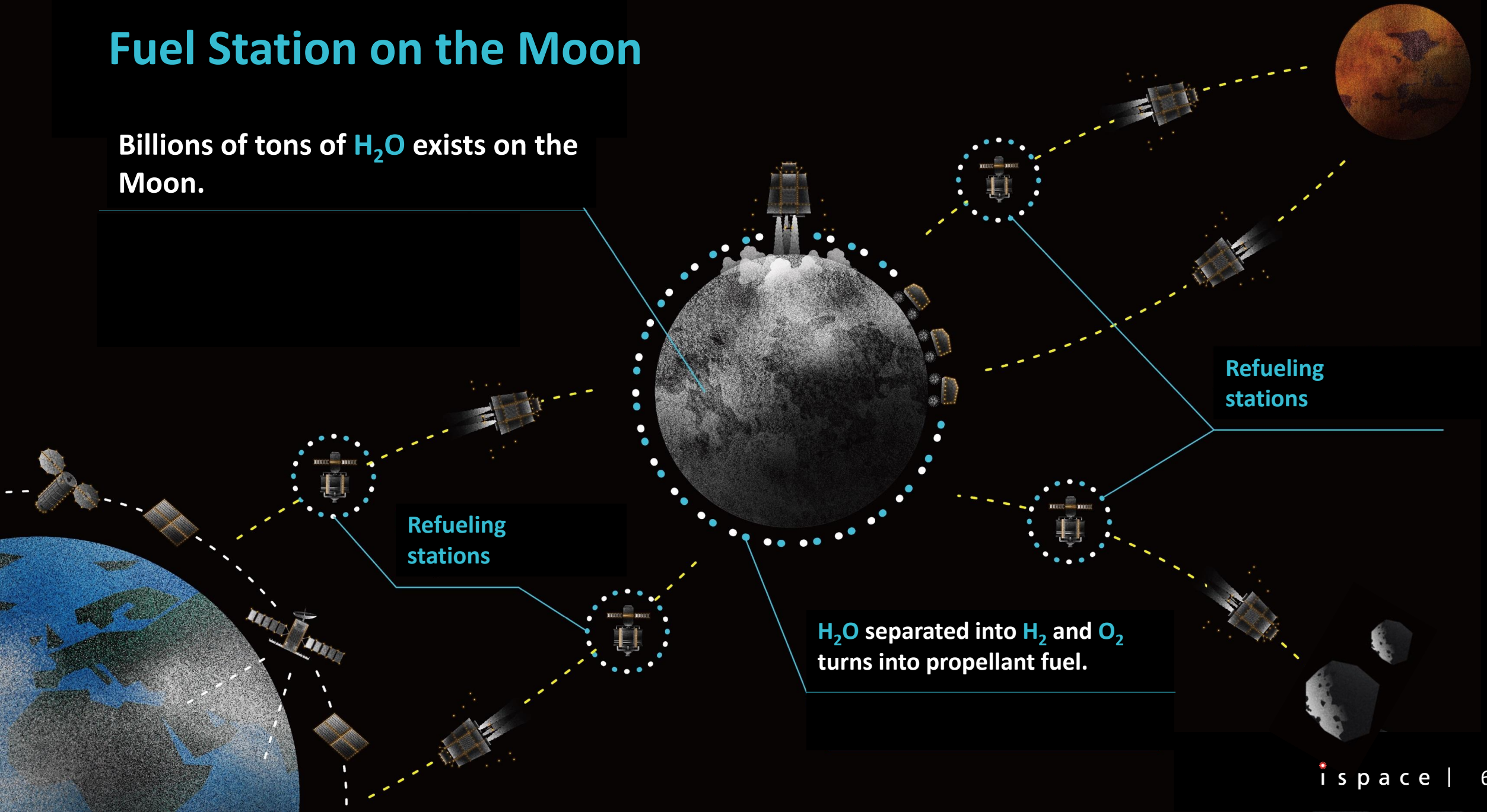
Moon Valley 2040

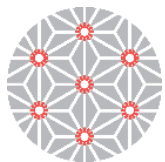
Expand our planet. Expand our future.

地球と月がひとつのエコシステムとなる世界を築くことにより、
月に新たな経済圏を創出する

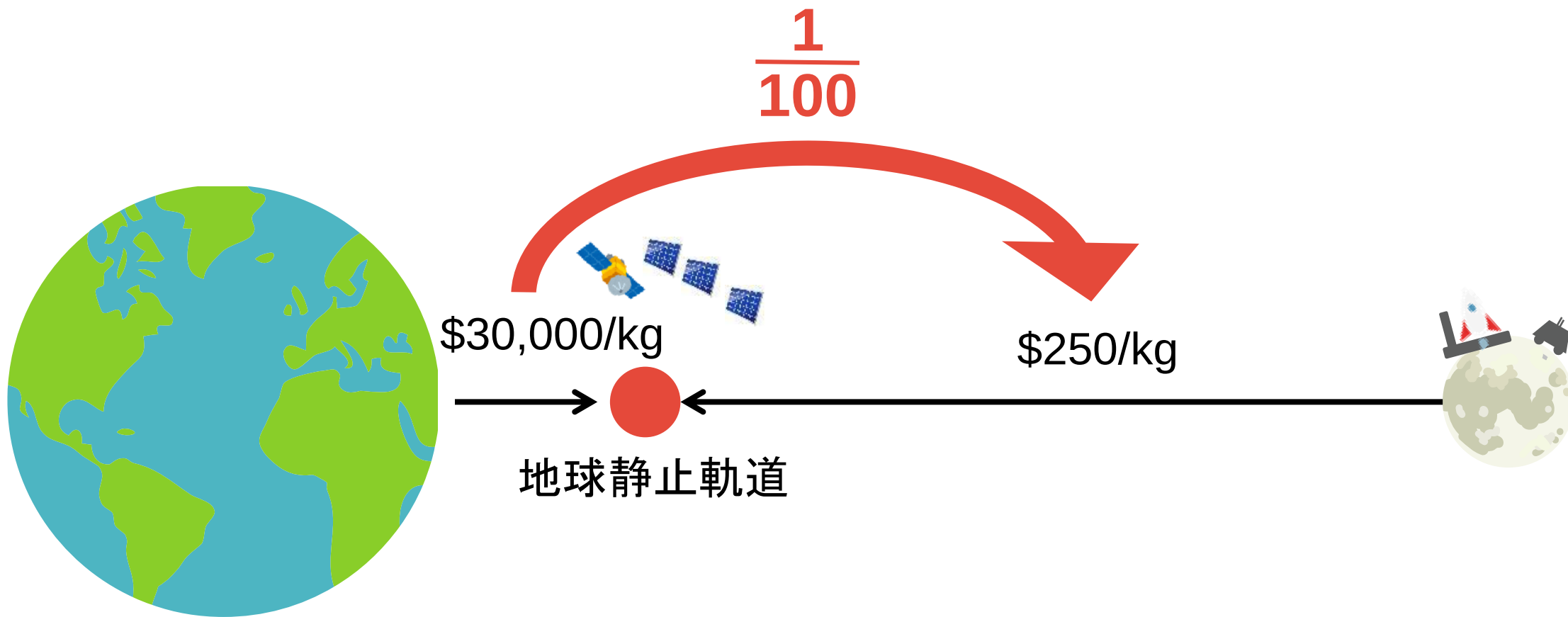
Fuel Station on the Moon

Billions of tons of H_2O exists on the Moon.





圧倒的な経済合理性：「月から資源を調達すれば、輸送コストは1/100」



出典: International Academy of Astronautics (2015)

月 x すべての産業



Current Landscape of Private Space Industry

宇宙の構造的シフトが進展中

1. 民営化

- 政府は限られた予算を、より Deep Space exploration に充てる傾向
- Cis-Lunar の宇宙開発は民間企業へ門戸が開かれる

2. 技術のコモディティ化

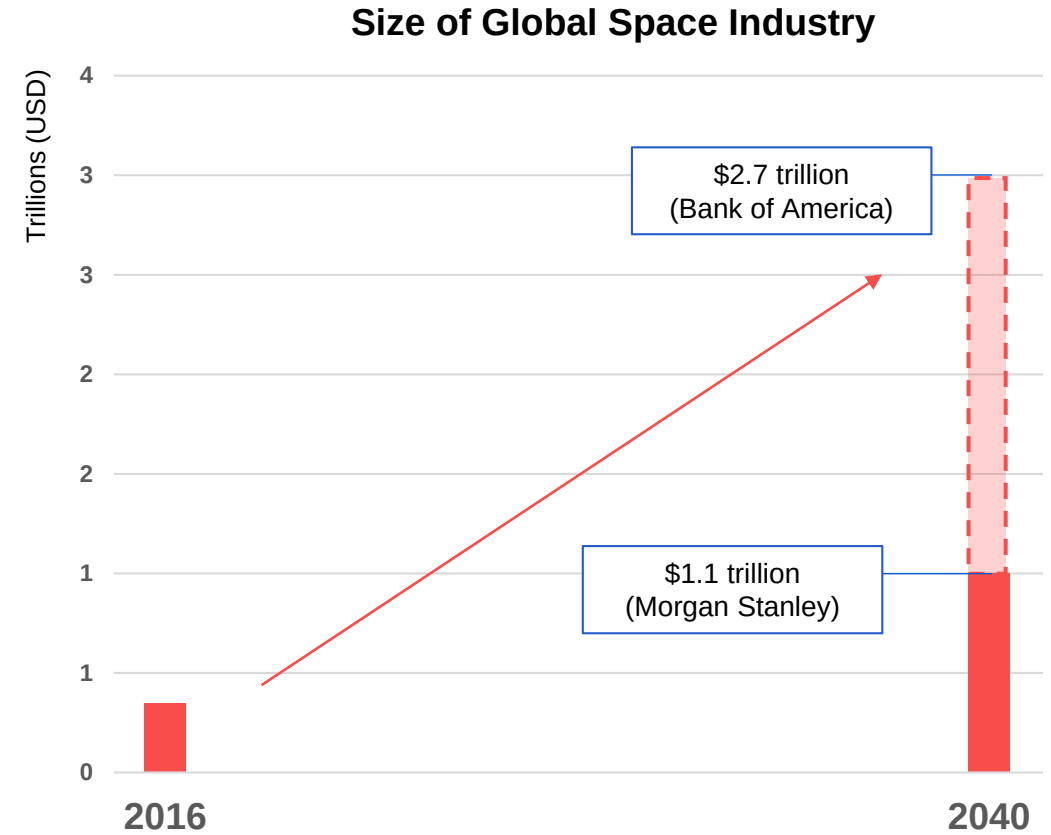
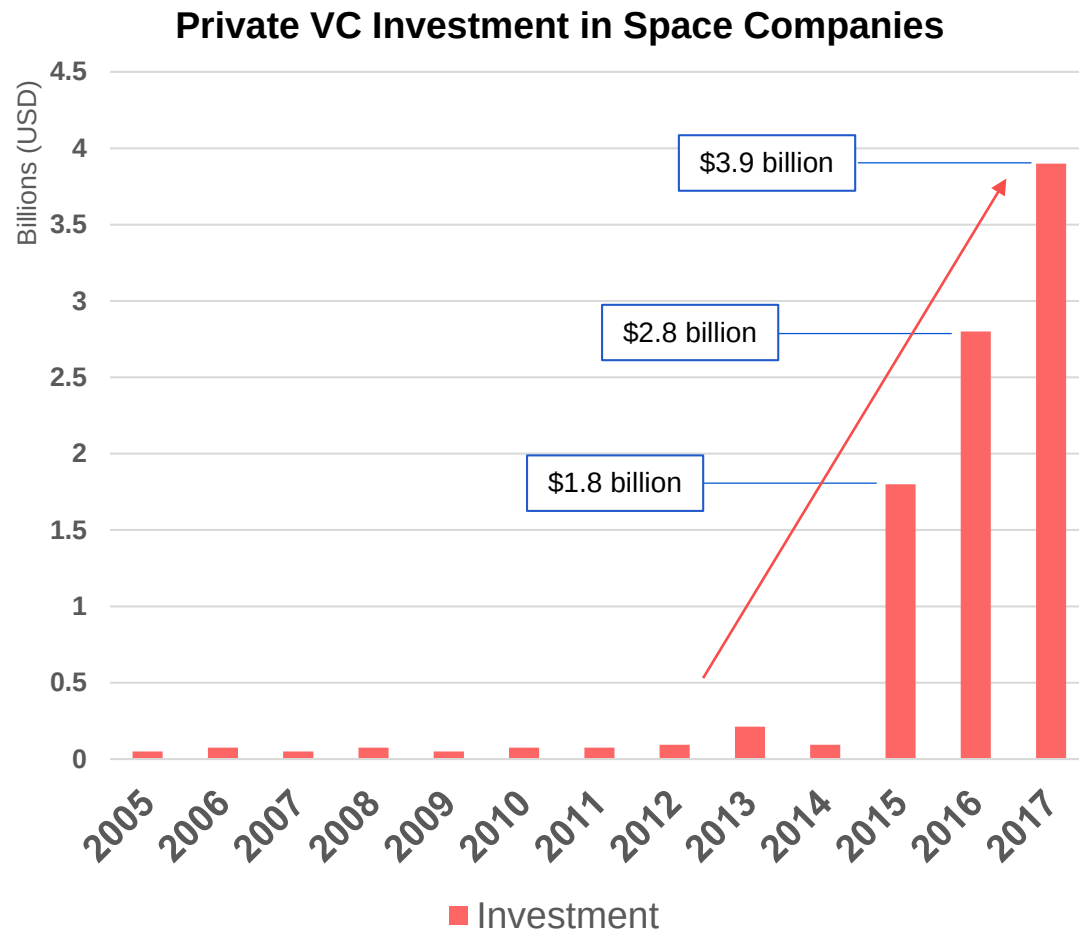
- 宇宙技術は既存技術と知見に基づくもの
- より低コストで高機能な民生品が市場に出回る
- ソフトウェアの進化が鍵

3. PPP

- 宇宙のビジネスは今後、Public-Private-Partnership 形式へ
- 民間が開発・運営を行い、政府はそのサービスを買う形式

加速拡大する宇宙産業の市場

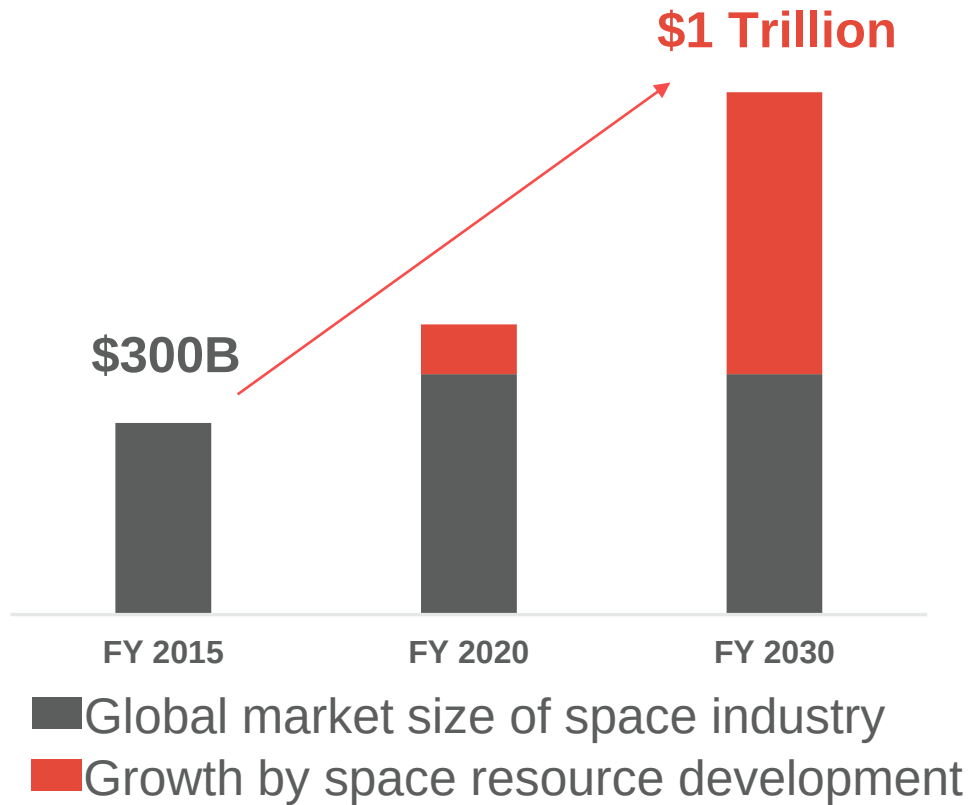
Record Investments and Industry Forecasts



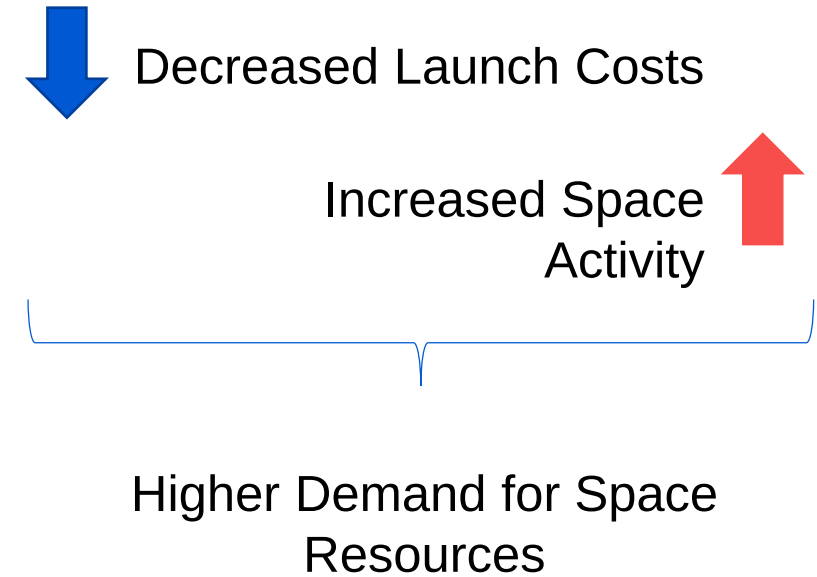
Source: The Tauri Group, Bryce Space and Technology, Space Angels and CNBC.

宇宙資源が、産業拡大のドライバー

Lower Launch Costs, Higher Space Activity Drive Resources Demand

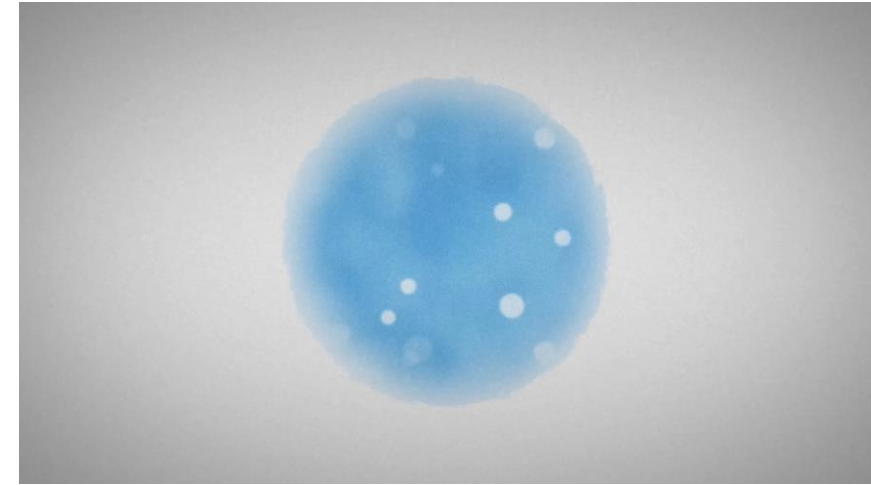


Source: ULA Cislunar 1000 Vision

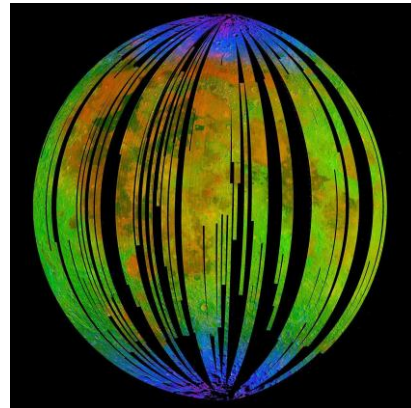


月面に水の存在の直接的な証拠が発見

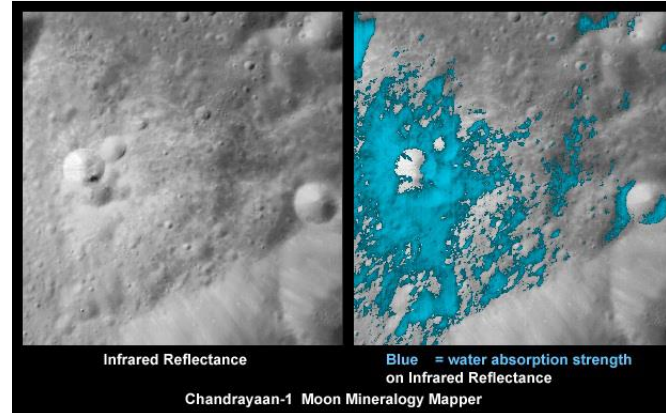
- **2008:** India's Chandrayaan-1 Moon Impact probe detects water on Moon's surface.
- **2009:** NASA's Moon Mineralogy Mapper & LCROSS space probe confirm water on the Moon's surface.
- Estimated 6 billion tonnes of H₂O



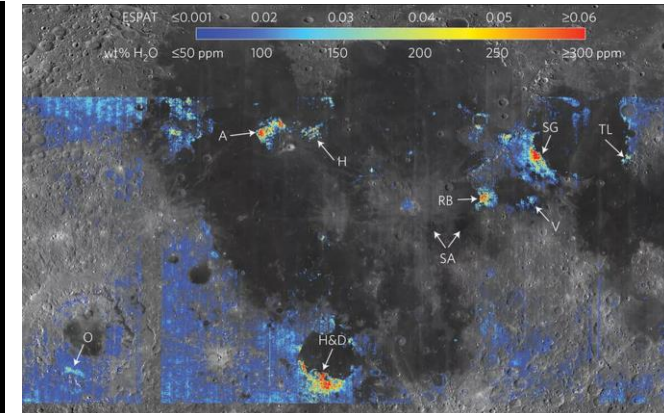
Source: NASA



Source: Indian Space Research Organization



Source: Indian Space Research Organization



Source: Nature Geoscience

月産業構築に向けた取り組みが活発化（Public Sector）

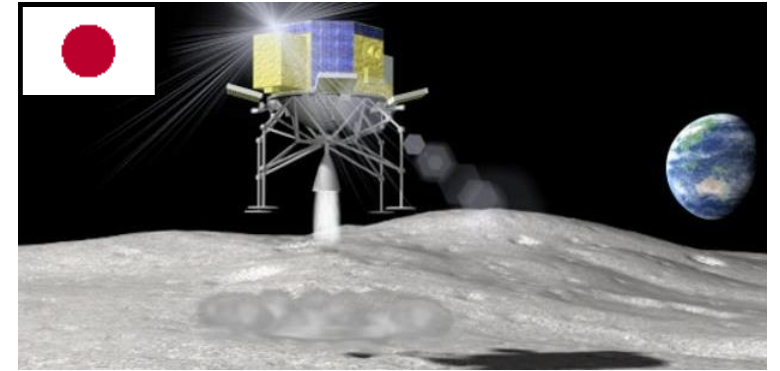
2019: India 1st Lunar Landing



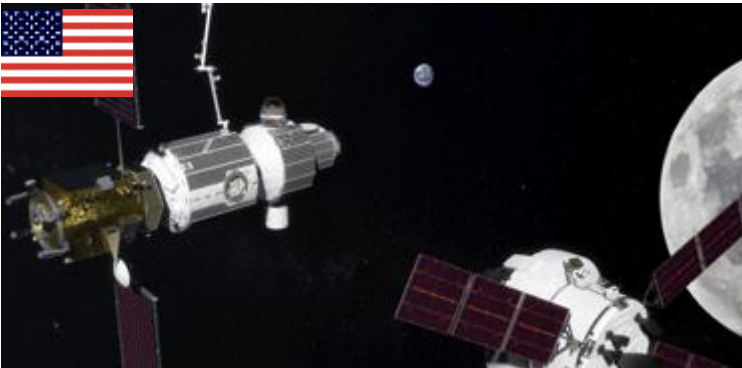
2019: China Far Side of Moon



2021: Japan Small Lunar Lander



2022: NASA Lunar Orbital Platform



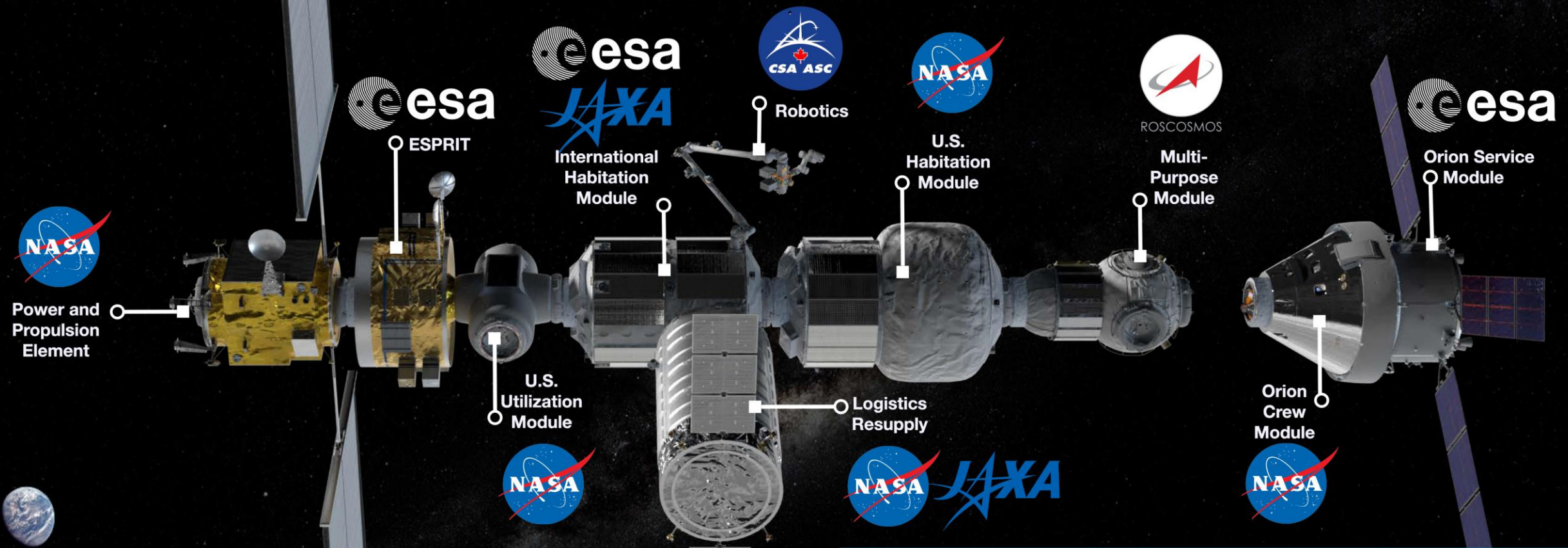
2029: Russia Moon Base



2030: ESA Moon Village

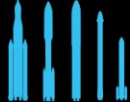
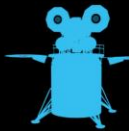


GATEWAY CONFIGURATION CONCEPT



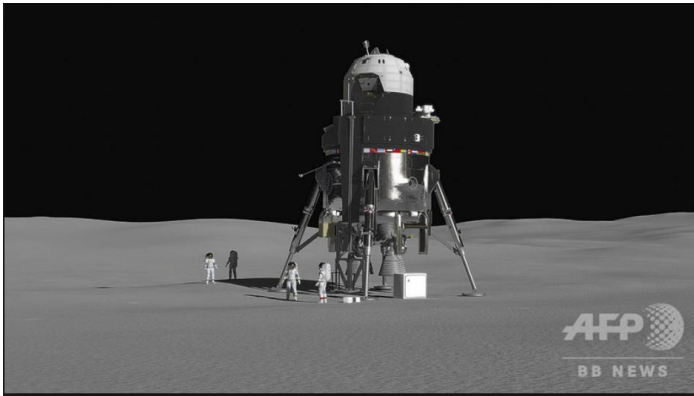
EXPLORE
MOON to MARS

A DEEP SPACE HUB FOR SCIENCE AND EXPLORATION COLLABORATION

 Command Module for Lunar Surface Assets	 Internal and External Payloads	 Internal and External Robotics
 Mixed Fleet Deliveries	 Human Lunar Surface Systems	 International Crew

月産業構築に向けた取り組みが活発化（Private Sector）

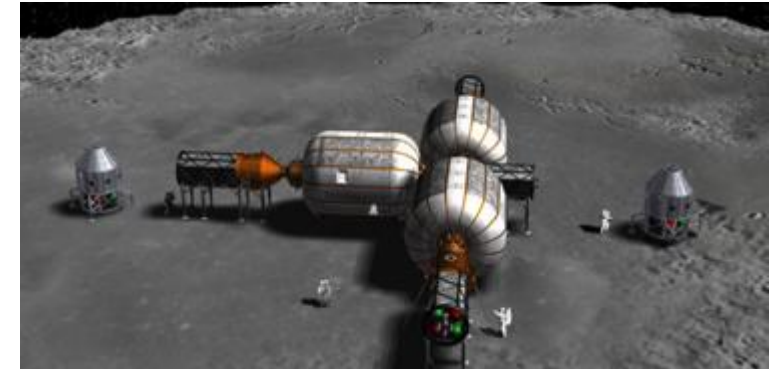
Lockheed Martin



Lunar XPRIZE



Bigelow Lunar Hotel



Boeing / SpaceX Crewed Missions



Blue Origin / SpaceX Moon Bases



TOYOTA





Targeting 2029 Mission

- 6m x 5.2m x 3.8m
- 6 ton
- 13 m³ (human habitable space)
- 2,000km traveling per mission
- 42 earth day working (day – night - day)
- 2 passengers
- Fuel cell (H₂ & O₂ will be carried from Earth)
- (Semi- ?) Automatic driving between each mission (*)

TOYOTA mentioned BRIDGESTONE is cooperating about wheel.



(*) During mission, human drive a rover. Other than mission, rover will go to next exploration point (semi-) automatically.

宇宙資源開発の政策



United States



Luxembourg



Japan



United Arab Emirates



China



Global

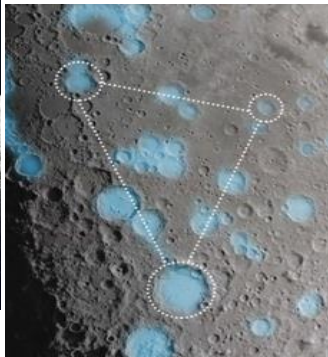


ispace ミッション

Vision実現に向けた 3-Step Approach

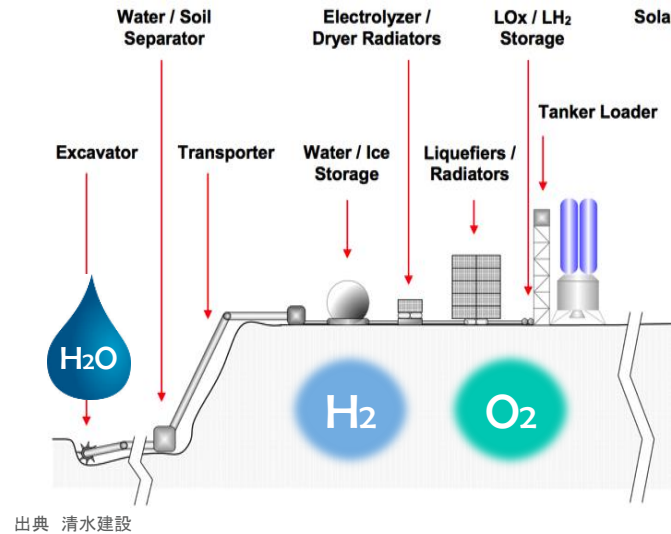
2020 Phase1

- ✓ 月への高頻度輸送サービス確立
- ✓ 月面資源データのマッピング



2030 Phase2

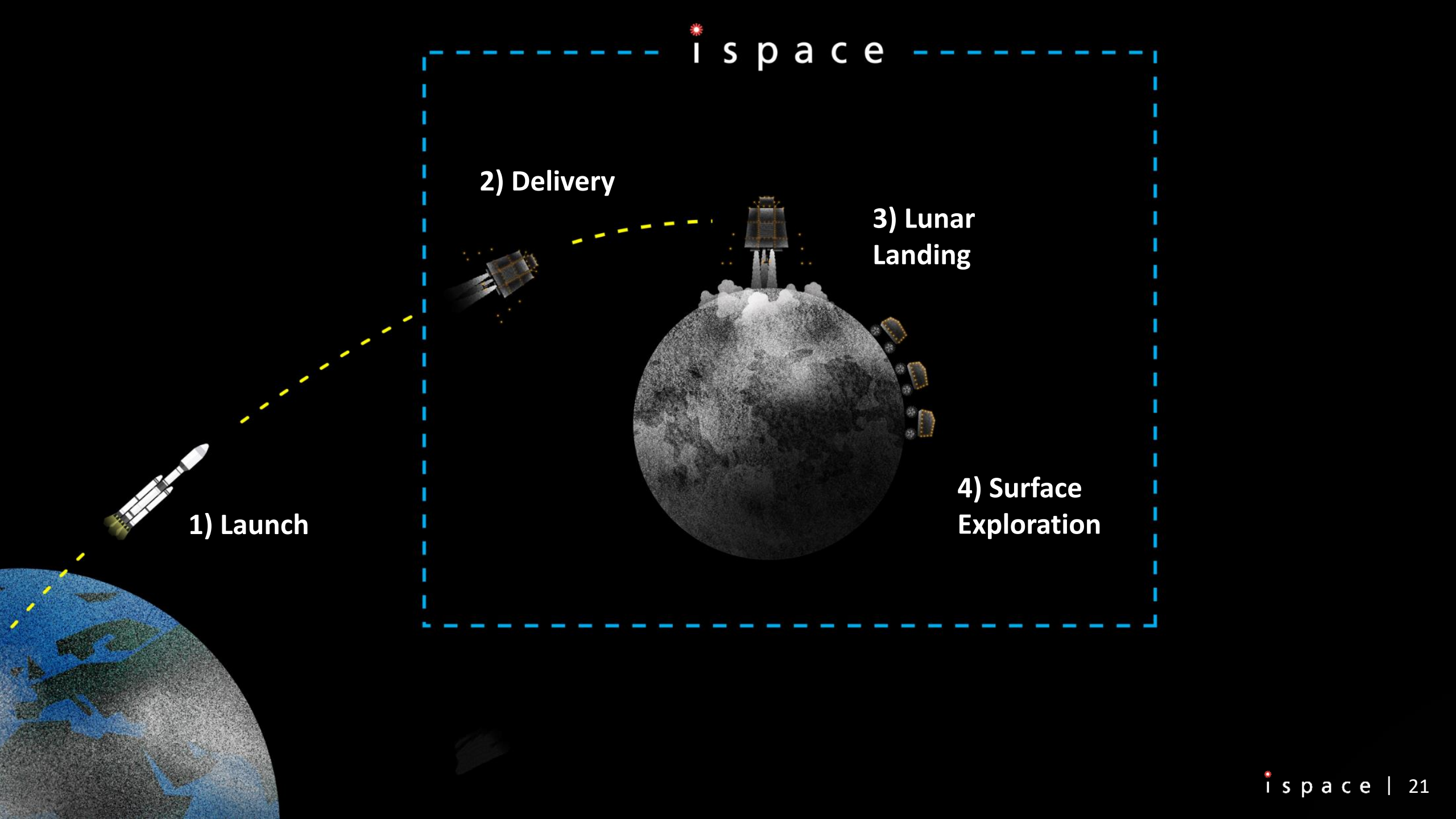
- ✓ 資源の採掘&貯蔵&加工システムを確立



2040 Phase3

- ✓ 地球と月を1つのエコシステムとする、宇宙インフラを軸とした経済の実現





ispace Hardware & Technology



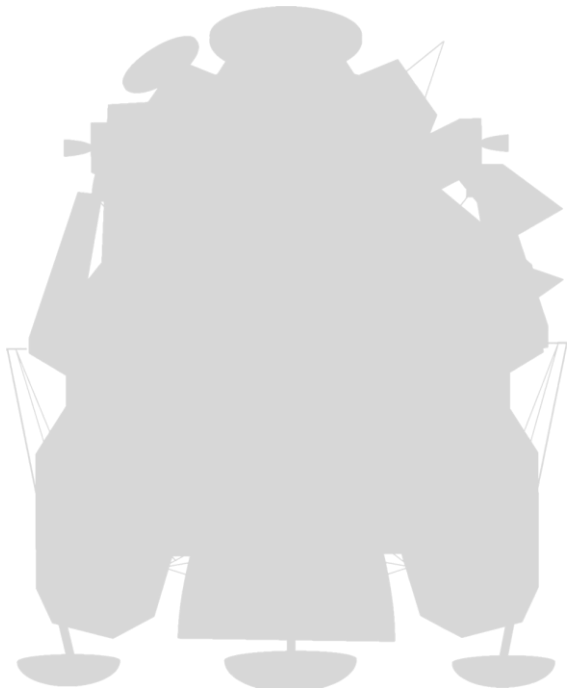
Lunar Lander



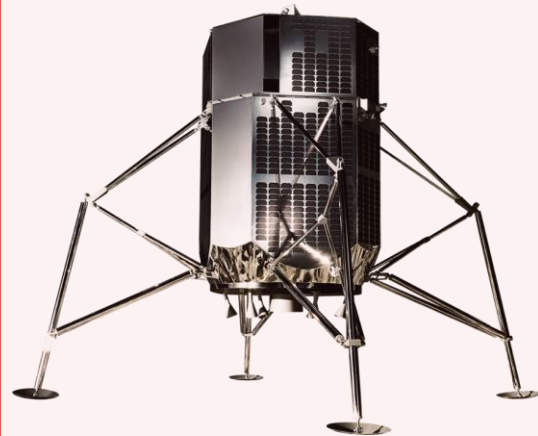
Lunar Rover

小型・軽量な宇宙機

ランダー（月面着陸船）



 Apollo Lunar Lander



 i s p a c e



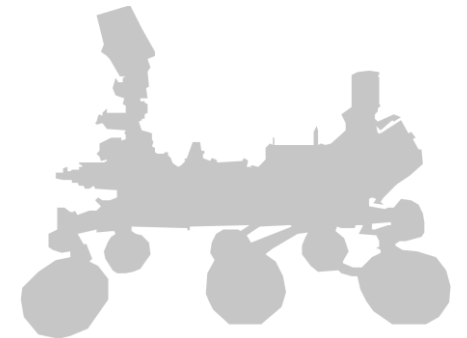
ローバー（月面探査車）



 i s p a c e



 Yutu



 Curiosity

月面を探索するローバー

Smallest and Lightest in the World



- ✓ Simulated Thermal Conditions Tested
- ✓ Solar Radiation Conditions Tested
- ✓ Launch Vibration Tested
- ✓ Simulated Lunar Terrain Tested
- ✓ Autonomous Hazard Avoidance

- Lunar water resource mapping
- Radiation counting
- 360-degree HD photo / video
- 3D terrain mapping
- Flexible and adaptable to other payloads

103.5億円

Series A Funding

- Record-largest Series A investment in Japan
- Financing for lunar lander development and Mission 1 & 2



*USD/JPY exchange rate Feb 2018



Mission Value

Mission1-2

Reach the moon,
explore lunar surface,
and demonstrate technology.



2021

2023

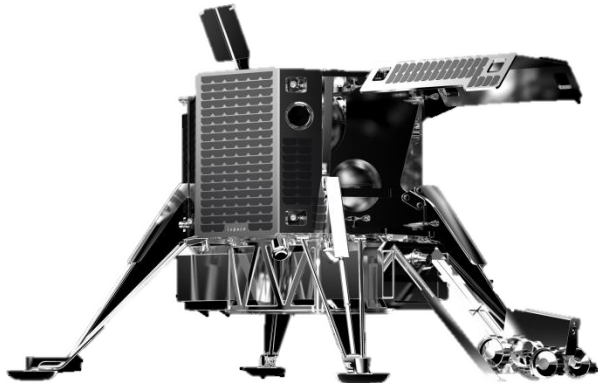
Mission3-

High-frequency, cost-effective
lunar transportation platform.

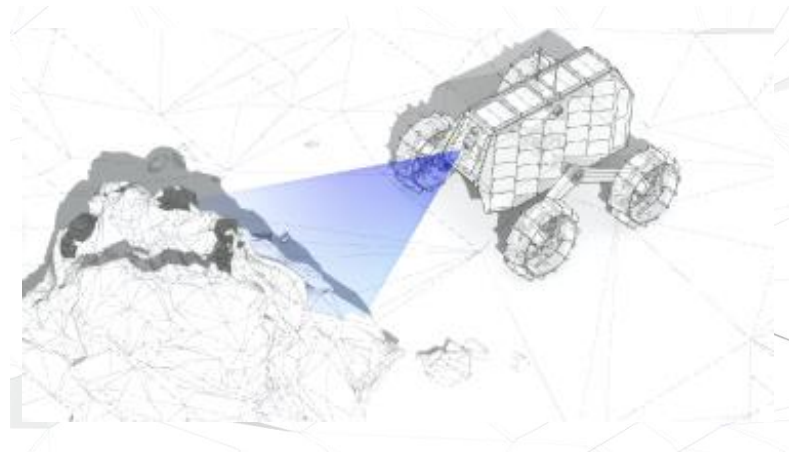


We Provide Three Business Services

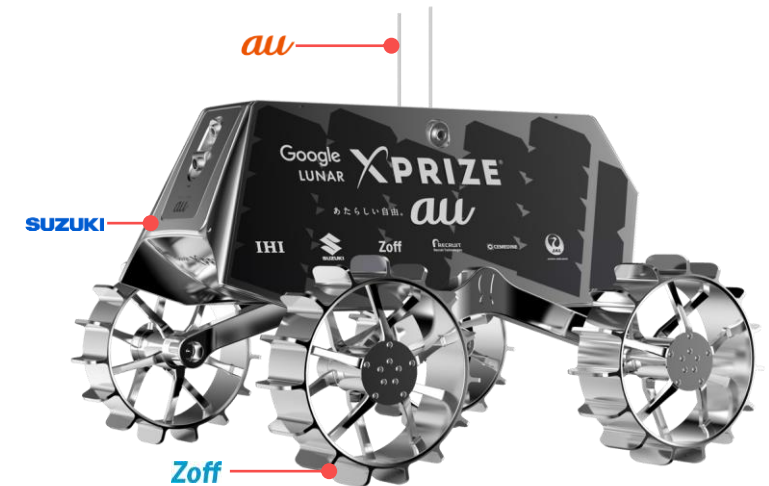
1. Payload Delivery



2. Lunar Data Collection



3. Sponsorship







Mission 1: 2021

Mission 2: 2023

"We are entering a new era in space exploration and SpaceX is proud to have been selected by ispace to launch their first lunar missions. We are looking forward to delivering their innovative spacecraft to the Moon."

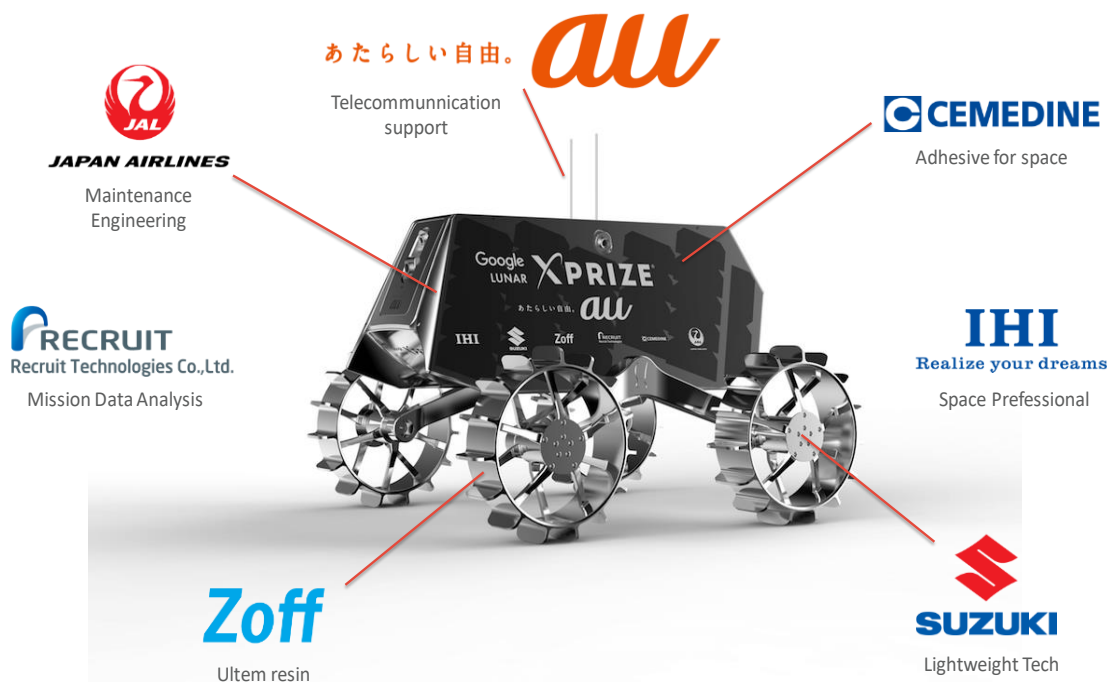
Gwynne Shotwell President and COO



非宇宙企業のR&Dプラットフォーム

Partnership on promotional and Tech / Business collaboration

HAKUTO Partners



New HAKUTO-R Partners



World's first Solid-State Battery test on the Moon



Creation of lunar exploration insurance



Lunar Industry Trading

Media Partners



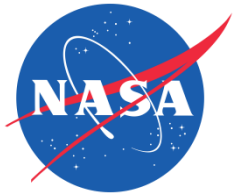
各国の宇宙機関との連携



- ESA: Signed a contract to develop a commercial offer for a European lunar ISRU mission (Dec, 2018)



- LUX: Signed 5 Years MOU on Lunar Resource Mining (March, 2017)



- NASA: Draper team has been selected as one of participants in Max. 2.6bn USD payload program (Nov, 2018)



- JAXA: Updated 5 Years MOU on Lunar Resource Mining (Aug, 2018)

ispaceを含む米ドレイパー研究所のチームが、NASAによる最大26億USDルのCLPSプログラムに選出



- Commercial Lunar Payload Service (CLPS)
- NASAのペイロード(荷物)を月へ輸送する商業サービスを、民間企業などから公募するプログラム
- 契約は2019年から10年間、契約総額は最大で26億USDル
- 2019年中に最初の発注を予定
- ただし、米国企業を優遇する制約あり



DRAPER

- ペイロード運用
- 月着陸船のGN&C
- システム開発
- 全体管理



GENERAL ATOMICS

- 月着陸船の製造・組み立て
- 米国での試験



ispace

- 月着陸船の設計
- ミッション運用
- 高頻度のペイロード輸送サービス

SPACEFLIGHT

- ロケット打ち上げサービス
- ペイロードインテグレーション



“One global team toward the Moon”

100 people

14 countries

3 offices

1 dream

Europe
Office



Tokyo Headquarters

NASA Ames
Research Park
Office

T h a n k y o u f o r y o u r a t t e n t i o n

