

Launch Services for the Moon

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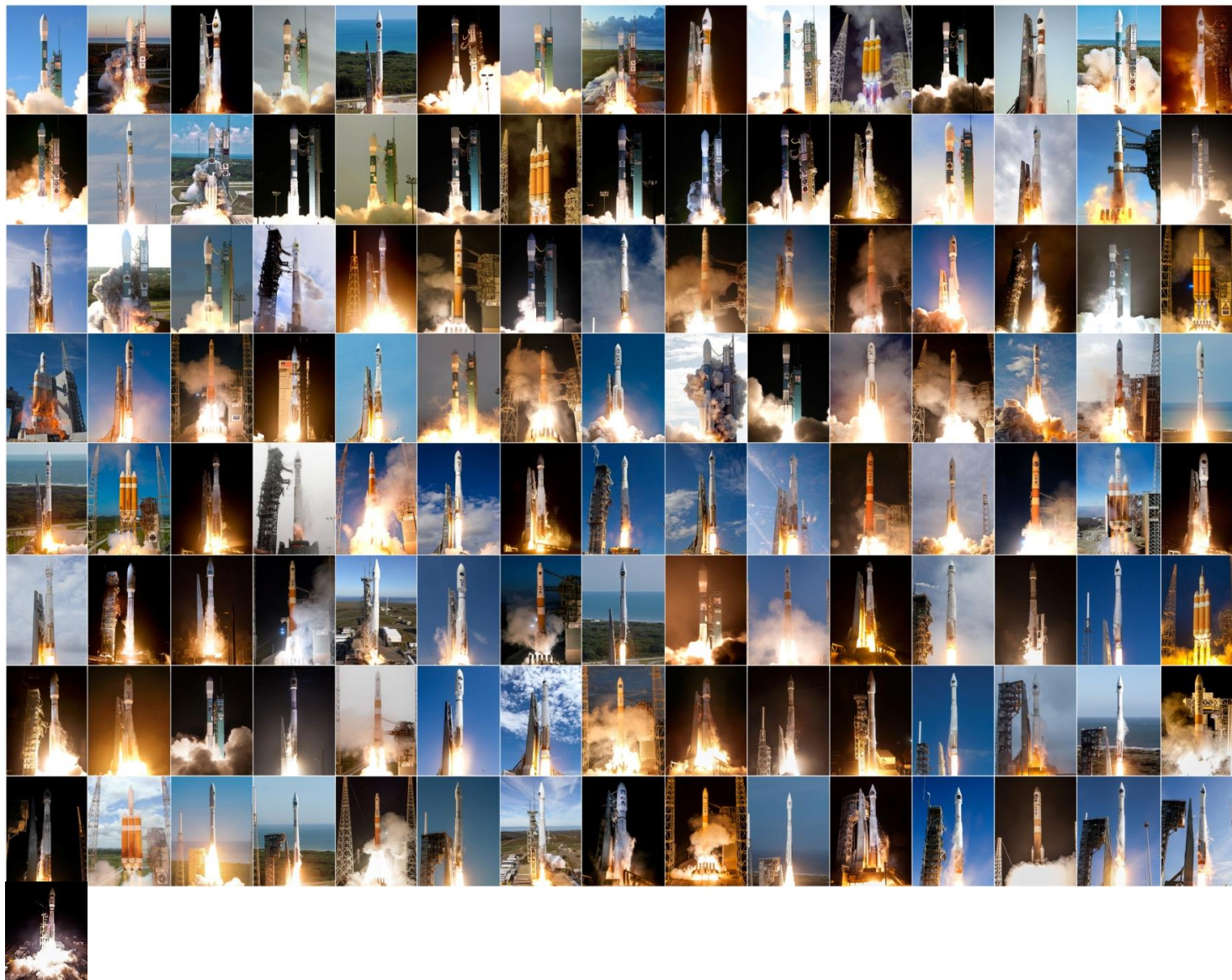
Oct. 2017





America's Ride to Space

One at a Time... 121! 100% Mission Success



CisLunar 1000 Vision

Road Map to the **CisLunar-1000 Economy**

Part 1: **TODAY**

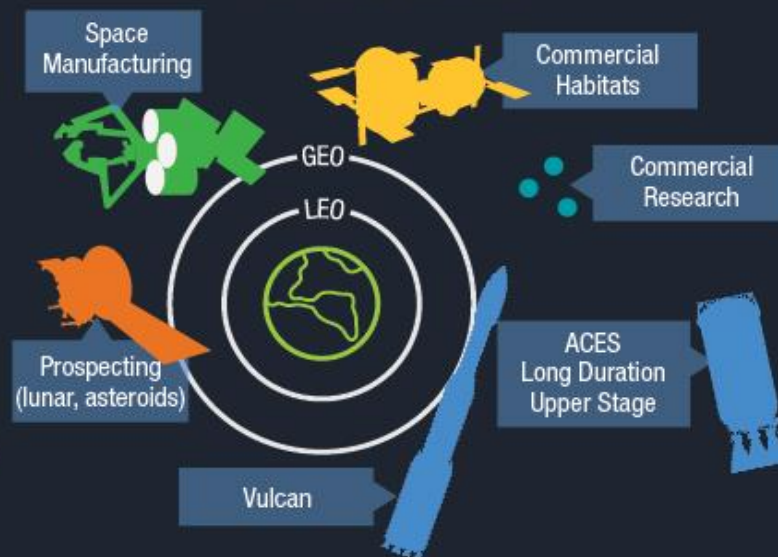


GROSS SPACE PRODUCT \$330B/YR

POPULATION x 5



Part 2: **5 YEARS**



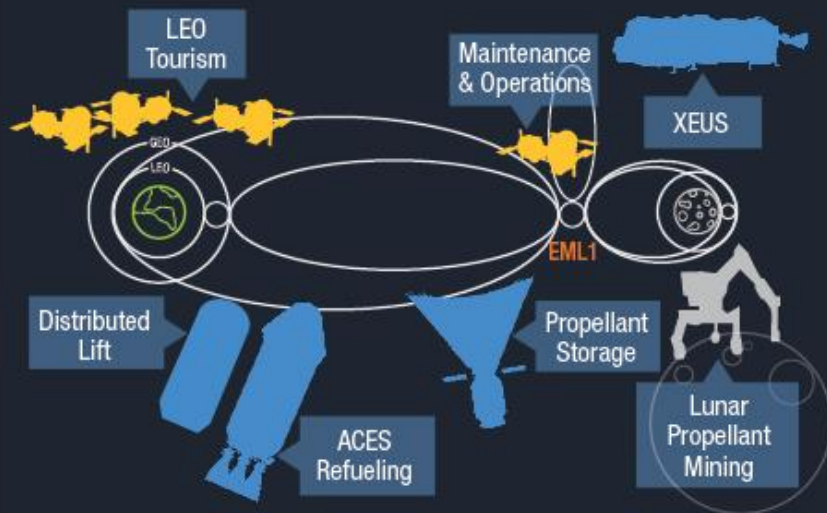
GROSS SPACE PRODUCT \$500B/YR

POPULATION x 20



CisLunar 1000 Vision

Part 3: 15 YEARS



GROSS SPACE PRODUCT \$900B/YR

POPULATION x 300



Part 4: 30 YEARS



GROSS SPACE PRODUCT \$2.7T/YR

POPULATION x 1,000

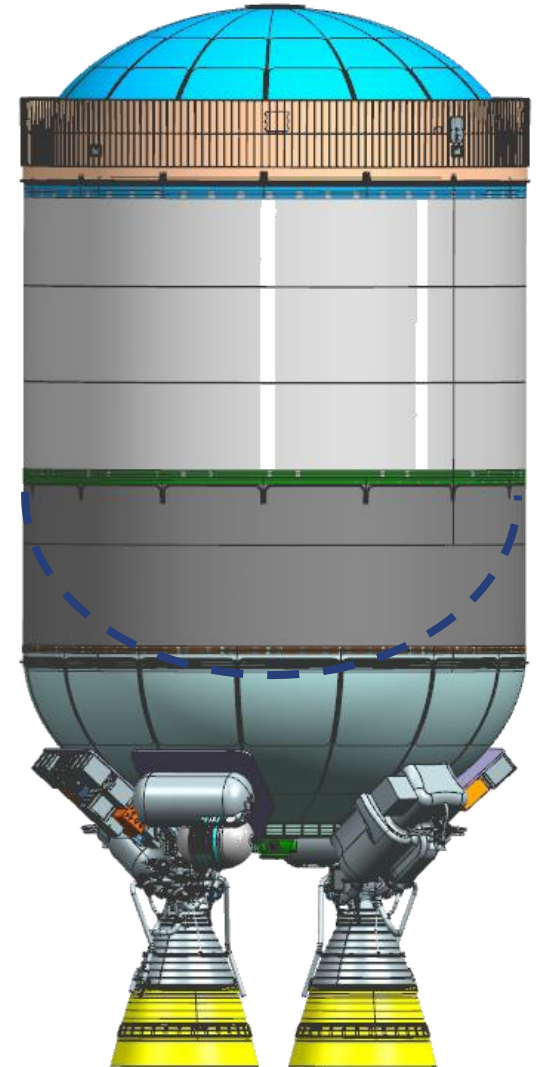


Video on Cis-lunar Commercialization



ACES – Advanced Cryogenic Evolved Stage

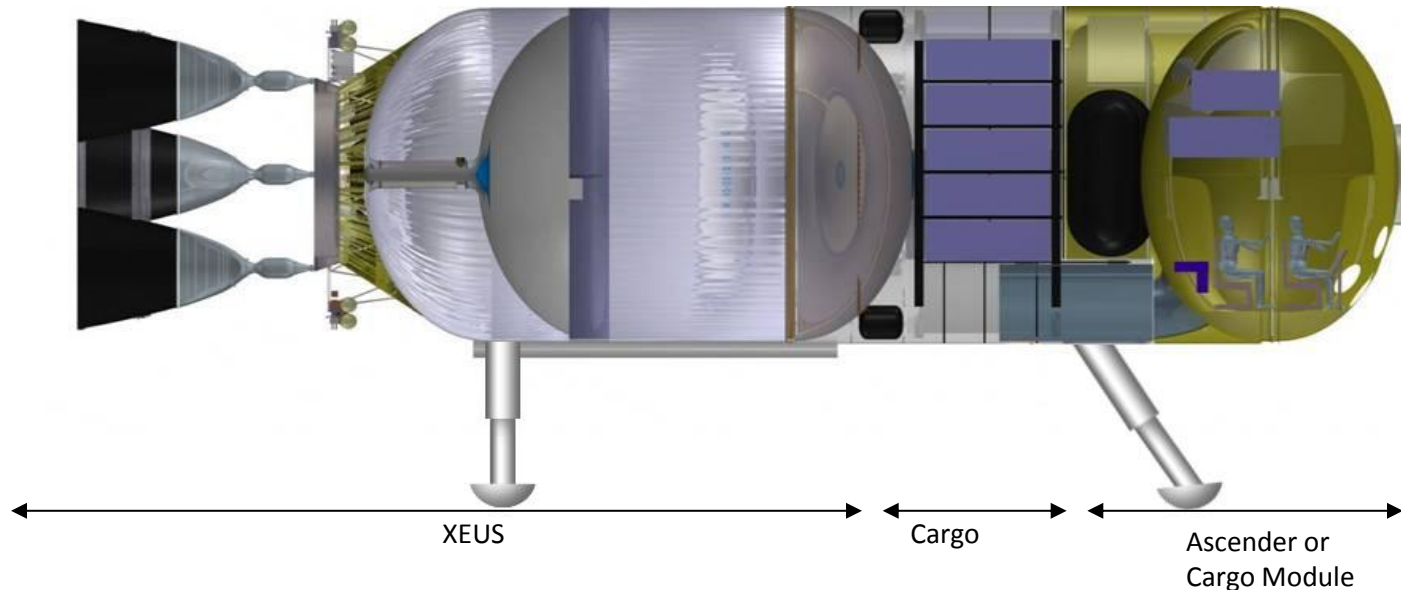
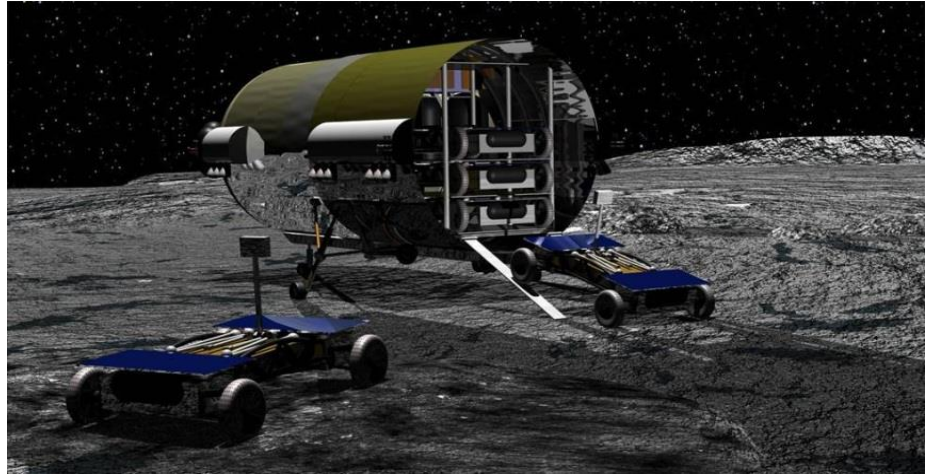
- ❑ New Mission Capability
 - Weeks Duration
 - Many Engine Burns
 - Increased Mission Flexibility
- ❑ Affordable
 - Atlas 541 performance for less than \$100M
- ❑ Integrated Vehicle Fluids & Cryogenics
 - Utilizing “waste” propellants to power subsystems
 - ❑ Power —> No Main batteries
 - ❑ Reaction control —> No Hydrazine
 - ❑ Pressurization —> No Helium



ACES is Key to Opening CisLunar Highway

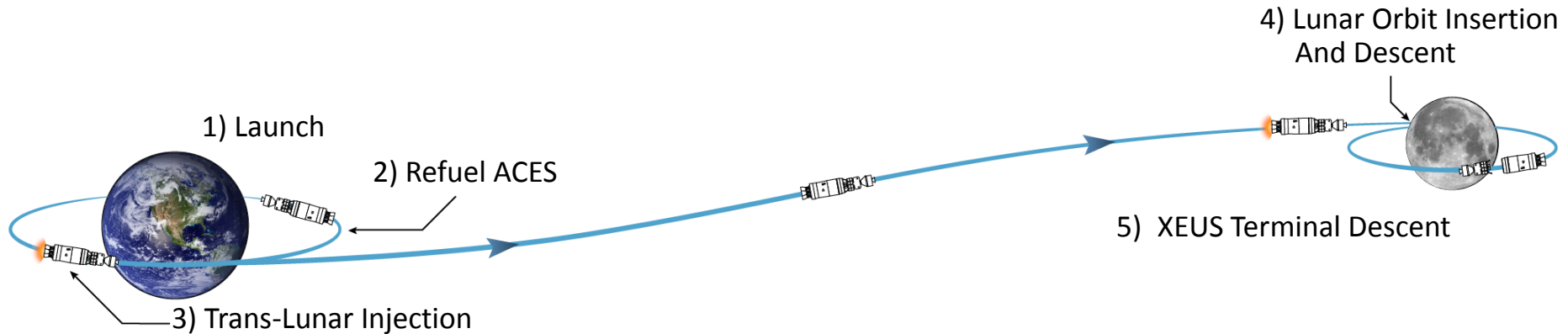
XEUS Large Scale Lunar Lander

- ❑ ULA's interests include lunar surface access
- ❑ ACES + Mission Kit
 - LH2/LO2 Thruster
 - Landing GN&C
 - Landing struts

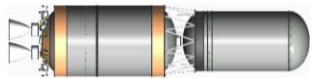


ACES and its XEUS variant can be the Cornerstone of Reusable CisLunar Transportation

Lunar Surface Cargo Evolution Distributed Launch



ACES & Propellant Tank



**Propellant
Transfer**

ACES/XEUS & Payload



• 12mT to the Lunar Surface

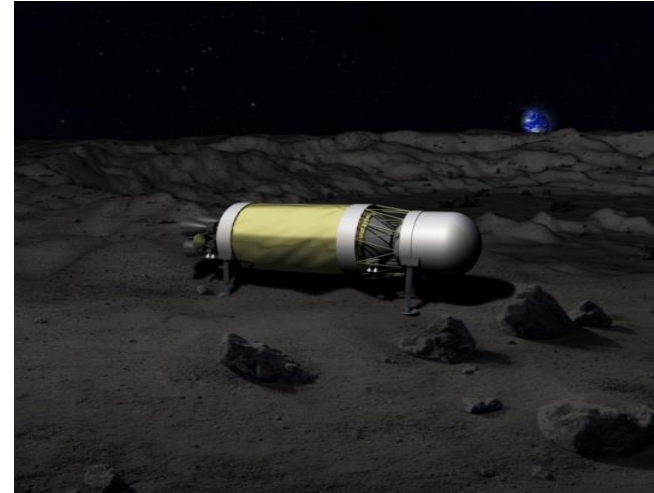
Lunar Propellant Mining Business Case

- ❑ Lunar sourcing of propellant may close a business case
 - If lunar propellant can be purchased in LEO for less than Earth launch

Water mined	1,575 mT/yr	Based on propellant at mixture ratio of 5.5 525 mT/yr excess oxygen
Lunar propellant produced	1,050 mT/yr	Based on ACES/XEUS transport from moon to LEO
Propellant delivered to LEO	210 mT/yr	Existing ULA demand
Price at the moon	\$0.5M/mT	Based on cost to transport to LEO Aerobraking could increase affordability by 2-3X
Price in LEO	\$3M/mT	Required to close business case
Total annual revenue	\$630m/yr	
Affordable non-recurring cost	\$3.5B	Total investment: development + delivery

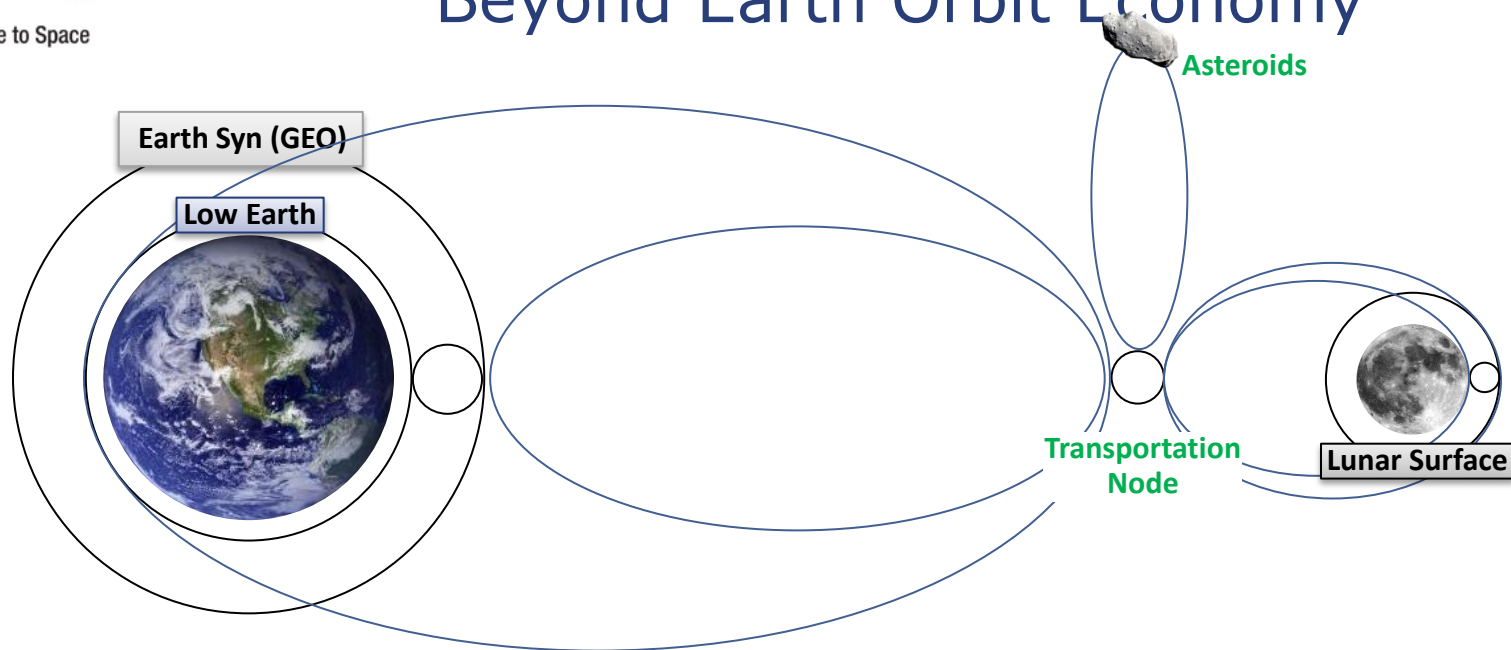
Launch Services for CisLunar Economy

- ❑ ULA ready to support the CisLunar economy with launch services and commercial synergies
- ❑ XEUS provides lunar cargo deliveries, building on ACES' revolutionary capabilities
 - IVF is a Revolutionary New Capability
 - ❑ Enables Long Duration Spaceflight & New Space Activities
- ❑ Enables Science, Prospecting, Mining, Manufacturing, etc.





Beyond Earth Orbit Economy



Low Earth Orbit

ISS
Remote Sensing
Commercial Station
Communication
Space Control
Debris mitigation
Science
R&D
Tourism
Manufacturing
Propellant Transfer
Data Servers

Earth Synchronous Orbit

Observation
Communication
Space Control
Debris Mitigation
Space Solar Power
Repair Station
Satellite Life extension
Harvesting

High Earth Orbit

Science / Astronomy
Communication Link
Way Station
Propellant Depots
Repair Station
Lunar Solar Power Sat
Manufacturing
Planetary Defense

Lunar Surface

Science/ Astronomy
• Lunar
• Observatory
Human Outpost
Tourism
Mining
• Oxygen/Water
• Regolith
• Rare Earth Elements
• HE3
Manufacturing
Fuel Depots
Solar Power to Earth

Existing market \ Emerging market \ Future market

The CisLunar Marketplace

- ❑ 100 Year Starship
- ❑ 490 Bio Tech Inc
- ❑ Accion Systems
- ❑ ACME Advanced Materials, Inc
- ❑ Aerospace Medical Association
- ❑ Agile Aero
- ❑ AIAA
- ❑ AIAA Rocky Mountain Sector
- ❑ Air Force College
- ❑ Alpha Space
- ❑ ALS (Adaptive Launch Solutions)
- ❑ Andrew Aldrin
- ❑ Angelus Funding
- ❑ Arconic
- ❑ Asia Pacific Aerospace Consultants
- ❑ Assn of Manufacturing Technology
- ❑ Astrobotics
- ❑ Axiom
- ❑ AxiSim Technologies
- ❑ Ball Aerospace
- ❑ Bank of America Merrill Lynch
- ❑ Barclays
- ❑ Bessemer Venture Partners
- ❑ Bigelow
- ❑ BioSpace Experiments, Inc.
- ❑ Black Sky
- ❑ Blue Origin
- ❑ Boeing
- ❑ Buzz Aldrin Space
- ❑ Caelus Partners
- ❑ CalTech
- ❑ CASI
- ❑ Chandah Space Technologies
- ❑ Coalition for Deep Space Exploration
- ❑ CO Office of Economic Dev't & Int'l Trade
- ❑ Colorado School of Mines
- ❑ Colorado University Boulder
- ❑ Commercial Space Flight Federation
- ❑ Deep Space Industries
- ❑ Deep Space Systems
- ❑ Deltion Innovations
- ❑ DexMat Inc
- ❑ Draper Laboratory
- ❑ Edge of Space Partner
- ❑ Effective Space
- ❑ Eli Lilly and Company
- ❑ Embry Riddle Aeronautical Univ.
- ❑ EOS of North America, Inc.
- ❑ EWI
- ❑ Excaliber Almaz
- ❑ FAA/AST
- ❑ Family Office Venture Capital
- ❑ FedEx
- ❑ Fiber Materials Inc
- ❑ Final Frontier Design
- ❑ Finance Technology Leverage
- ❑ Florida Institute of Technology
- ❑ FOMS Inc
- ❑ Fort Wayne Metals
- ❑ GE Oil & Gas
- ❑ GHO Ventures, LLC
- ❑ Google
- ❑ Greenfield Resources
- ❑ Heinlein Prize Trust
- ❑ Henry Ford Health System
- ❑ Houston Angel Network
- ❑ Humanity Innovation Labs
- ❑ ID Global Partners
- ❑ Immortal Data Incorporated
- ❑ Innovation Labs
- ❑ Intuitive Machines
- ❑ Iridium
- ❑ iSpace
- ❑ JACQ Technologies
- ❑ JesTech
- ❑ Jet Propulsion Laboratory
- ❑ Kelso Aerospace
- ❑ Little Prairie Services
- ❑ Lockheed Martin
- ❑ Lunar and Planetary Institute
- ❑ Made In Space
- ❑ Mankins Space Technology
- ❑ ManSat
- ❑ Mars Interstellar
- ❑ Masten Space Systems
- ❑ MD Anderson Cancer Center
- ❑ Merck Research Laboratories
- ❑ Metro Denver Econ. Dev't Corp.
- ❑ micro-gRx
- ❑ MOOG broad Reach
- ❑ Moon Express
- ❑ Nano Racks
- ❑ NASA Ames
- ❑ NASA HQ
- ❑ NASA Johnson Space Center
- ❑ NASA Marshall
- ❑ NASA STMD
- ❑ National Space Biomedical Research Institute
- ❑ National Space Society
- ❑ Naval Research Labs
- ❑ Near Earth LLC
- ❑ New Mexico State University
- ❑ NY Center for Space Entrepreneurship
- ❑ NewSpace NYC
- ❑ Northrop Grumman
- ❑ Oceaneering
- ❑ Oceanit
- ❑ Offworld Consortium
- ❑ Offworld Industries
- ❑ Orbital ATK
- ❑ OSD & Virginia Spaceflight Authority
- ❑ OSD/NA
- ❑ Perella Weinberg Partners
- ❑ Planet Labs
- ❑ Planetary Resources
- ❑ PoliSpace
- ❑ Poulos Air & Space
- ❑ Purdue University
- ❑ Quilty Analytics
- ❑ Rice Univ. Space Institute
- ❑ RRE Ventures
- ❑ Satellite Applications Catapult
- ❑ Schafer Corporation
- ❑ Secure World Foundation
- ❑ Shakelton Energy
- ❑ Shell Exploration and Production Company
- ❑ Sierra Nevada
- ❑ Silicon Valley Space Center
- ❑ SouthWest Analytic Network, Inc.
- ❑ Space Angels
- ❑ Space Florida
- ❑ Space Foundation
- ❑ Space Frontier Foundation
- ❑ Space Mining Coalition
- ❑ Space Policy
- ❑ Space Systems Loral
- ❑ Space Tourism Society
- ❑ SpaceCom
- ❑ Spacepharma
- ❑ Surrey Satellite Technology
- ❑ Tau Zero Foundation
- ❑ Tethers Unlimited/Spiderfab
- ❑ TransAstra
- ❑ TYVAK
- ❑ United Launch Alliance
- ❑ University of Houston
- ❑ Urthcast
- ❑ Virgin Galactic
- ❑ Vulcan Aerospace
- ❑ Xtraordinary Innovative Space Partnerships, Inc. - XISP-Inc.