



# NewSpace: The "Emerging" Commercial Space Industry

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# Learning Outcomes

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**At the end of this lecture you should be able to:**

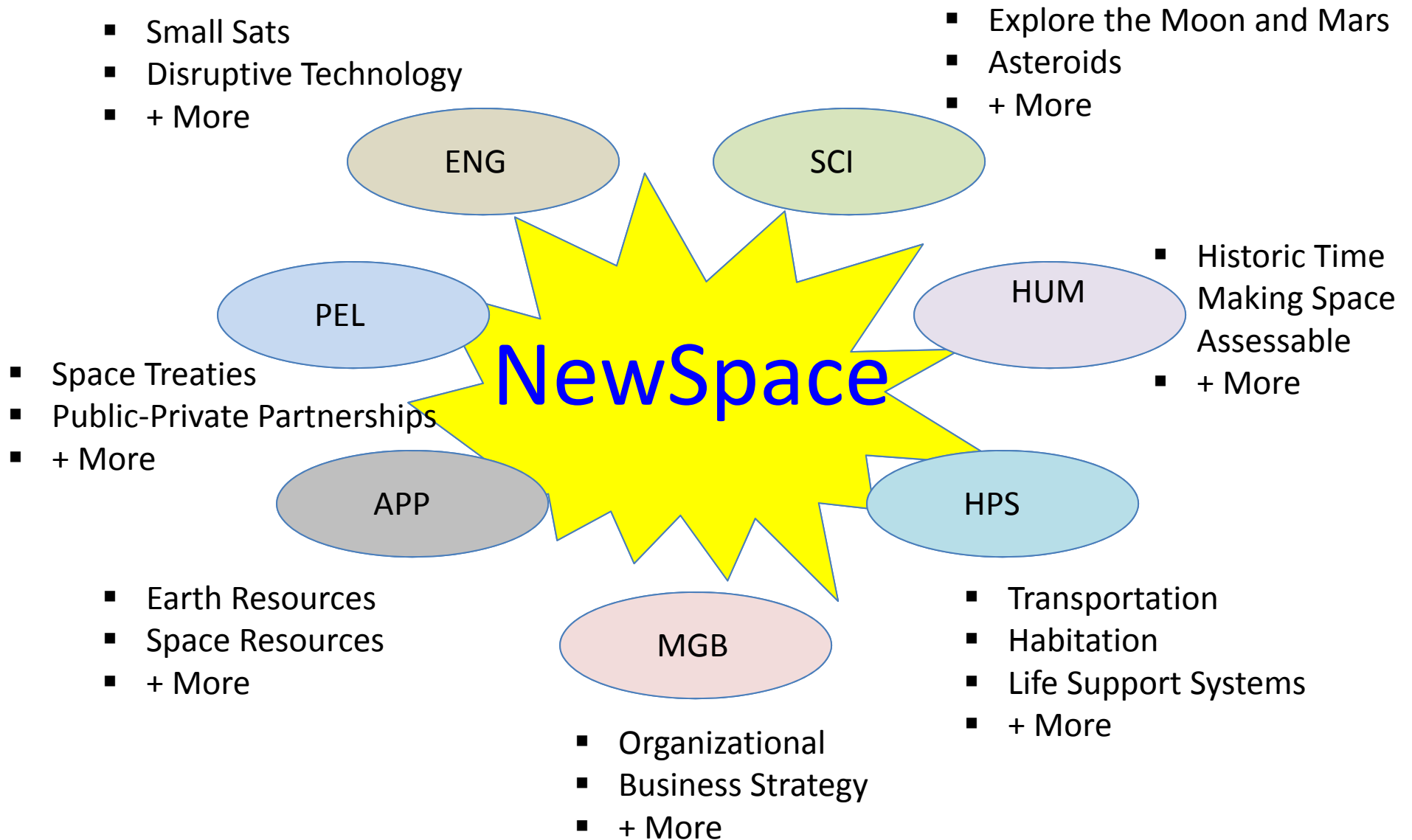
- 1) Describe different regimes where commercial space is starting to take hold
- 2) Describe in what areas entrepreneurial companies are developing new markets
- 3) Name a few companies that are examples of the commercial space revolution
- 4) Discuss how governments can facilitate the birth of this new industry

# Why is this lecture important?

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- We are at a turning point in the history of space exploration and development – the cusp of a revolution, new industries are being born that use space in many different ways
- The established military industrial space sector is no longer the only game in town
- Increased competition and new capabilities will change the market place forever
- Everyone interested in working in the space sector will be effected

## 3 – I Links



# Outline

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- **Regimes for NewSpace Opportunities**
  - Suborbital
  - Orbital
  - Deep Space
- **Example NewSpace Companies**
- **Government's Role in Promoting NewSpace**
- **Organizations Promoting NewSpace**

# What is NewSpace?

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- **HobbySpace.com**

“Alt.space, NewSpace, entrepreneurial space, and other labels have been used to describe approaches to space development that differ significantly from that taken by NASA and the mainstream aerospace industry.”

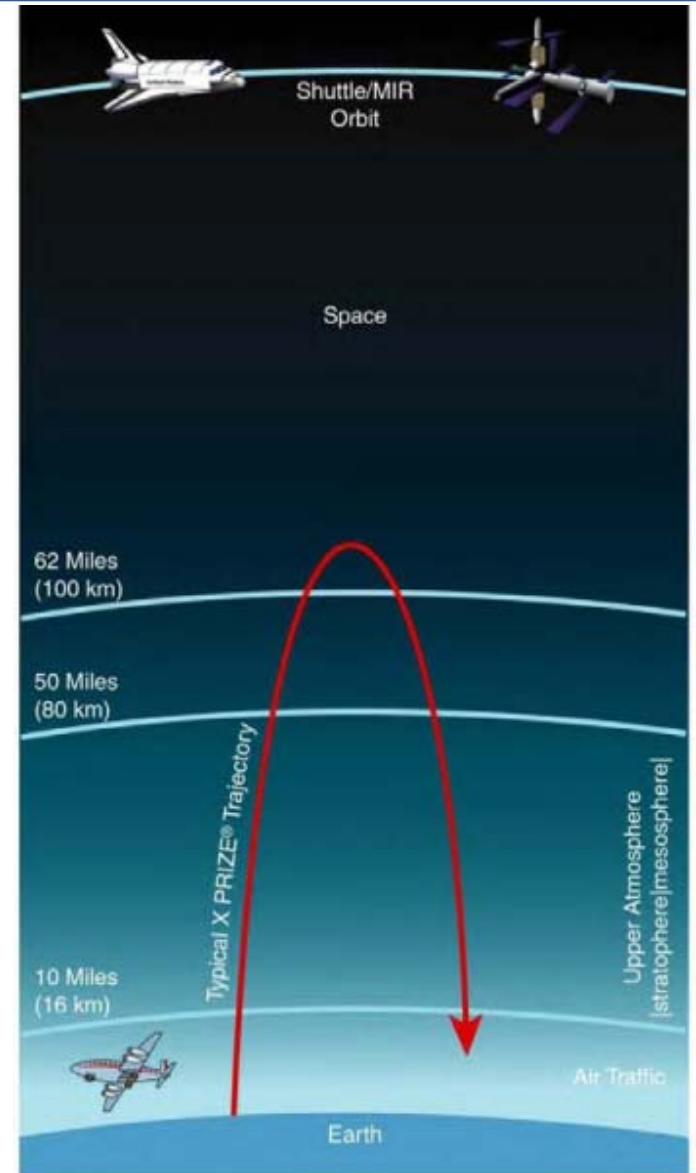
- **From Wikipedia:**

“NewSpace, alt.space, and entrepreneurial space are umbrella terms for a movement and philosophy often affiliated with, but not synonymous with, an emergent private spaceflight industry. Specifically, the terms are used to refer to a community of relatively new aerospace companies working to develop low-cost access to space or spaceflight technologies and advocates of low-cost spaceflight technology and policy.”

# Regimes for NewSpace Opportunities

## Suborbital

- **Description:**
  - Spacecraft reaches space 100 km (62 miles) or higher but does not have the forward velocity to go into orbit (e.g. 7.7km/s at 300 km)
- **Tourist Industry**
  - Companies are selling tickets for the suborbital experience, trips for \$250K Virgin Galactic to \$95K/\$100K XCOR per seat
- **Research**
  - Microgravity (around 4 minutes)
  - Upper atmospheric measurements
  - Technology demonstrations
  - Life Science experiments
- **Point-to-Point Travel**
  - Travel from one location on Earth to another through space
  - Challenging technical problems
  - Long-term goal not a current focus

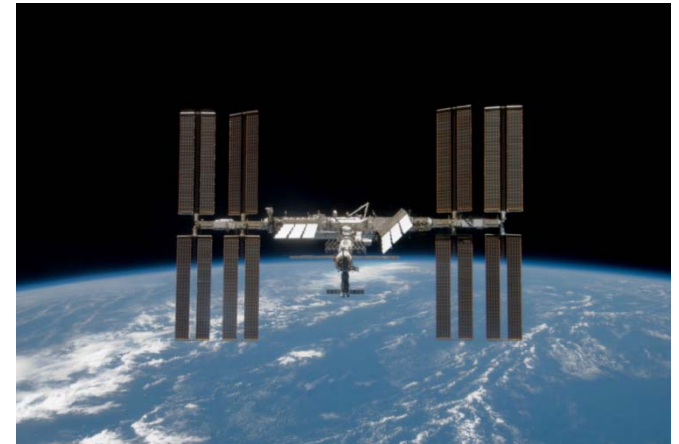




# Regimes for NewSpace Opportunities

## Orbital

- **Description:**
  - Low Earth Orbit (LEO) between 180 – 3000 km
  - High Earth Orbit (HEO) – Geocentric 35,786 km
- **Tourist Industry**
  - Spend long periods of time in microgravity at ISS or on private space stations
  - Space Adventures: 7 private citizens to ISS (8 missions – \$20M – \$40M per trip)
- **Research/Applications**
  - Conduct experiments continuously in the orbital environment (microgravity and life sciences)
  - Launch small sats from ISS
- **Satellite Servicing**
  - Service satellites, put them in proper orbits, refuel, fix and upgrade systems

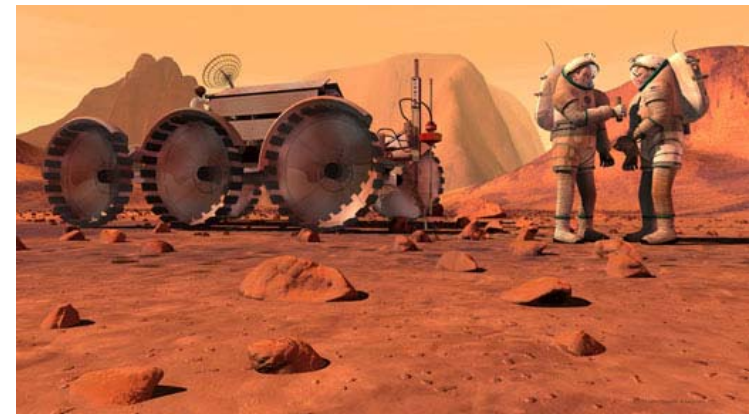




# Regimes for NewSpace Opportunities

## Deep Space

- **Description:**
  - Libration/Lagrange points, Moon, Asteroids, Mars and beyond
- **Tourist/ Explorers**
  - Ultimate in exotic experiences
  - The Inspiration Mars Foundation
  - \$750M per seat to the Moon; Golden Spike
- **Research**
  - Enabling Humans to be productive and happy in space; in-space economy
  - Developing new materials and processes to create new markets and improve life
- **Mining and In Situ Resource Utilization**
  - Examples: Propellants, metal & materials processing, and building materials
- **Servicing a space-based economy**
  - Examples: 3D printing in space
- **Settlement**
  - Moving human civilization to Moon and Mars



# Example NewSpace Companies

	Masten Space Systems	Copenhagen Suborbital	Zero2Infinity	Xcore	Virgin Galactic	Blue Origin	Swiss Space Systems	Sierra Nevada Corporation	Nanoracks	Planet Labs	Bigelow Aerospace	Space Adventures	SpaceX	Space Adventures	Orbital Sciences	Moon Express	Golden Spike	Planetary Resources	Deep Space Industries
Sub-Orbital																			
Orbital																			
Moon																			
Asteroids																			
Mars																			



## Suborbital - Companies

# ZERO2INFINITY

**Headquarters:** Cerdanyola del Vallès, Spain

**Founded:** 2009 by Jose Mariano Lopez-Urdiales, CEO and Founder (ISU Masters)

**Major Focus:** Earth/Space observation, Atmospheric science, Drop testing and Technology demonstration

**Implementation:** Series of increasingly capable balloons fly to 36 km



**Capacity:** For Bloon: Four passengers and two crew

**Cost:** €110K (around \$149K) per seat

**Major Partnerships:** la Caixa, Large Spanish Bank



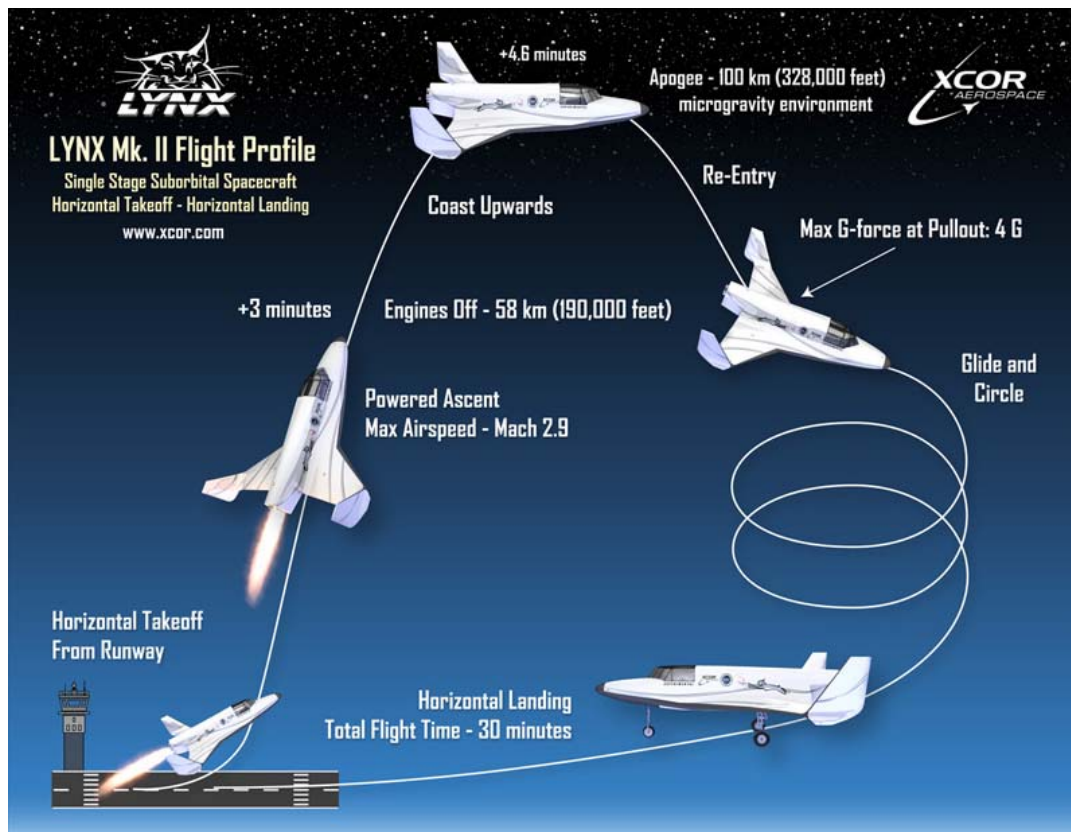
## Suborbital - Companies

# XCOR Aerospace

**Headquarters:** Mojave, California USA, with R&D Headquarters in Midland, Texas USA and operational base at Cape Canaveral, Florida.

**Founded:** 1999; Jeff Greason (President and Co-Founder)

**Major Focus:** Space tourism and research



**Capacity:** One passenger and one pilot per flight of the Lynx

**Cost:** \$95K (Mark I)/\$100K (Mark II) per Seat

**Major Partnerships:** January 2013 Unilever and Space Expedition Corporation (SXC) bought 22 flights for Global AXE Campaign. Citizens in Space has purchased 10 flights.



## Suborbital - Companies

# Virgin Galactic

**Headquarters:** Las Cruces, New Mexico USA

**Founded:** 2004 by Richard Branson (Virgin Group); George Whitesides (CEO)

**Major Focus:** Space tourism and research

**Implementation:** White Knight Two will air launch rocket powered SpaceShipTwo, reusable horizontal take off and landing.



**Capacity:** Up to 6 passengers and two pilots or up to 600kg of payloads

**Cost:** \$250K per seat

**Major Partnerships:** Spaceport America in New Mexico;

**Next Steps:** First commercial operations planned for 2014





## Suborbital and Orbital Companies

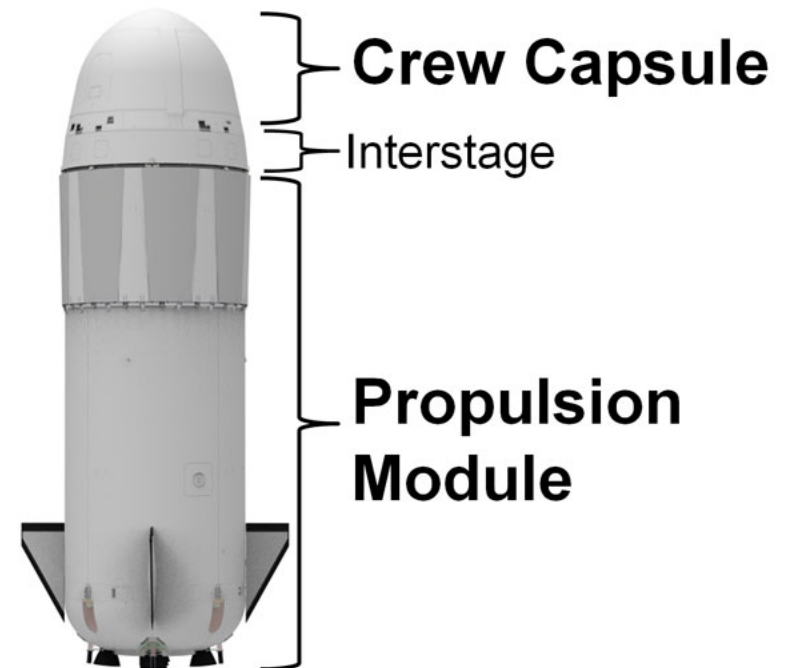
# Blue Origin, LLC

**Headquarters:** Kent, Washington USA (launch site: Van Horn, Texas USA)

**Founded:** 2000 by Jeff Bezos (founder and CEO of Amazon.com)

**Major Focus:** Tourism and research

**Implementation:** New Shepard system, rocket powered vertical take off and vertical landing, reusable first stage and reusable capsule – suborbital and orbital



**Capacity:** Suborbital : New Shepard – 3 or more passengers

**Cost:** Unknown

**Major Partnerships:** NASA CCDev 1&2 (\$25.7M); ULA for Atlas V



## Suborbital and Orbital Companies

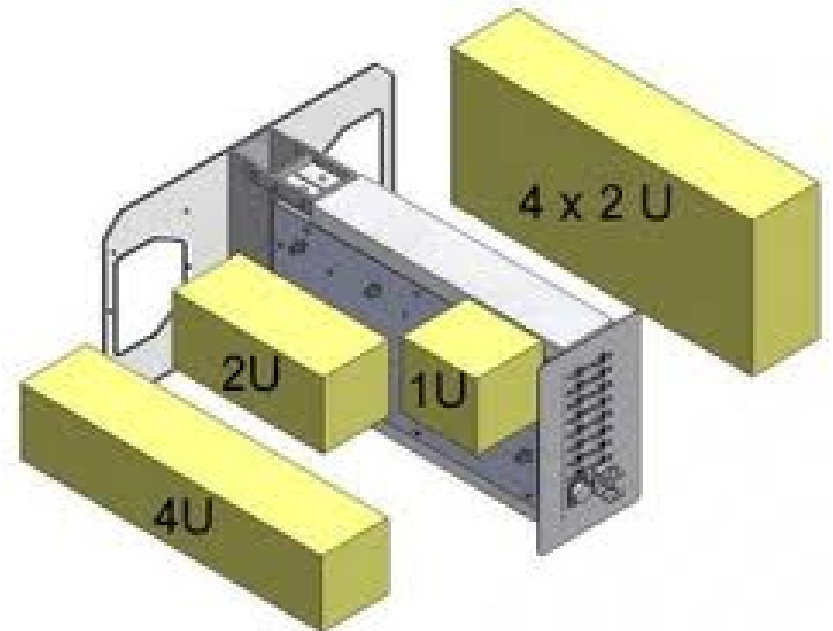
# Nanoracks

**Headquarters:** Houston, Texas USA

**Founded:** 2009 CEO Jeff Manber (MirCorp)

**Major Focus:** On-orbit research and small sat launch

**Implementation:** Nanoracks research platforms on ISS follow cubesat form factor



Various sizes of CubeLab modules and a NanoRack platform

**Capacity:** Each platform has 32 payload slots.

**Cost:** Educational clients: payload (1U) can be as low as \$30K, 2U is \$60K. Commercial payloads start at \$60K per 1U, and non-US payloads are charged at a higher rate.

**Major Partnerships:** XCOR for Suborbital, Astrium for ISS External Platform Program, and Entropy Engineering (2010 NASA SBIR)







# Orbital Planet Labs

**Headquarters:** San Francisco, CA USA

**Founded:** Will Marshall, Robbie Schingler, Chris Boshuizen

**Major Focus:** Applications; Earth Sensing

**Implementation:** Fleet of Small Sats called Doves; uses modern manufacturing methods, Flock 1 (28 satellites) launched Feb 2014



**Capacity:** +100 small sat; resolution 10 square feet.

**Major Partnerships:** Draper Fisher Jurvetson (DFJ)



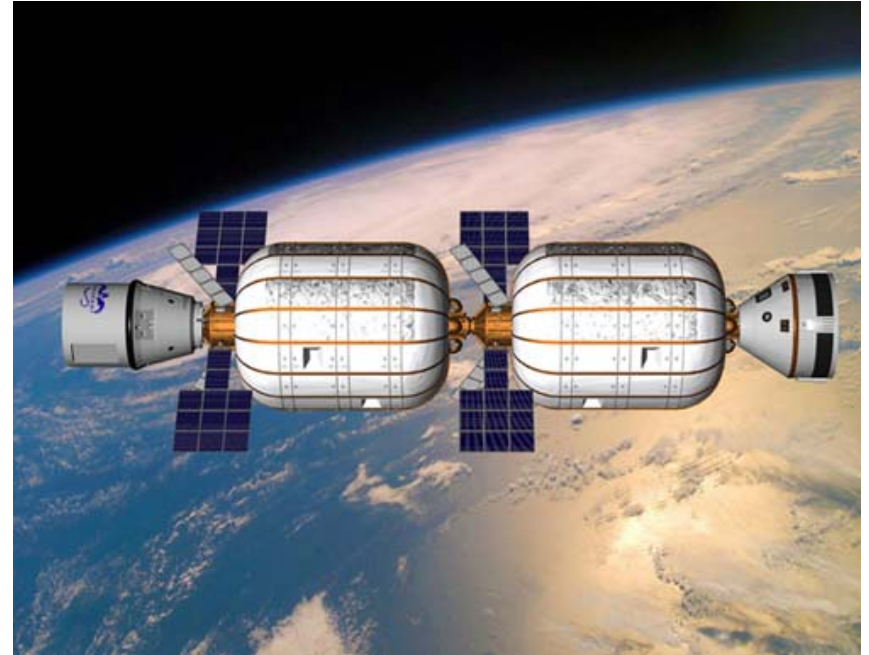
## Orbital Bigelow Aerospace

**Headquarters:** North Las Vegas, Nevada USA

**Founded:** 1999 by Robert Bigelow, Founder and President (Budget Suites of America)

**Major Focus:** Commercial space stations, multiple uses, potential customers include nations without human spaceflight programs

**Implementation:** Expandable space habitat technology based on NASA Transhab design.



**Cost:** \$25M for 110 cubic meters for 2 months; trip cost \$26.25M (Dragon) or \$36.75M (CST-100)

**Major Partnerships:** SpaceX and Boeing/ULA



## Orbital and Deep Space Companies

# Space Exploration Technologies (SpaceX)

**Headquarters:** Hawthorne, California

**Founded:** 2002 by Elon Musk CEO and CTO (co-founder of PayPal); Gwynne Shotwell (President)

**Major Focus:** Cargo and passengers to LEO (ISS), Geostationary Transfer Orbit, and planetary missions

**Implementation:** Vertically organized, most development and manufacturing done in-house. Falcon launch vehicles and Dragon capsules.



**Capacity:** Dragon – can support up to 7 crew

**Cost:** For Falcon Heavy - \$84M up to 6.4t to GTO; \$128M greater than 6.4t to GTO

**Major Partnerships:** NASA  
Commercial Crew Development (CCDev 2)







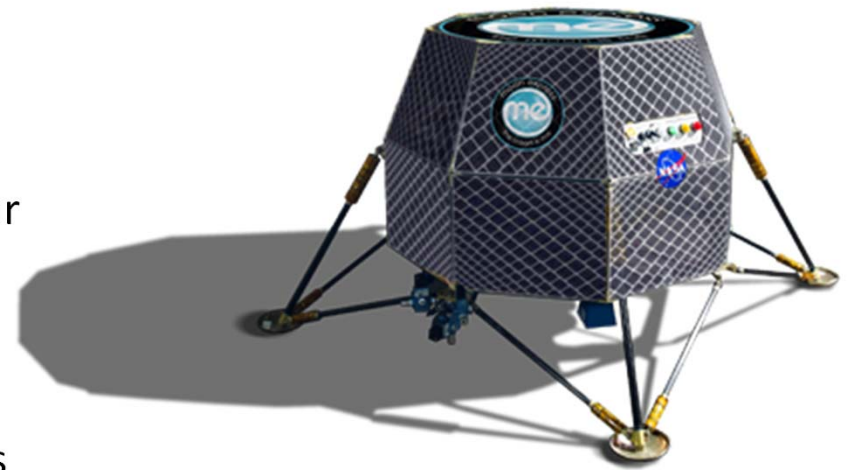
## Deep Space Moon Express

**Headquarters:** NASA Research Park, Moffett Field, California USA

**Founded:** 2010, Co-Founder and CEO, Bob Richards (ISU co-founder)

**Major Focus:** Delivering payloads to the Moon, Lunar resource exploration, Google Lunar X Prize Competition

**Implementation:** Deliver payloads, explore for valuable resources, and lunar sample return missions



**Capacity:** Developing series of increasing capable lander platforms, from ~50kg to 400+kg

**Cost:** For 'hard' payloads costs start around \$3M/kg and are expected to come down to around \$1M/kg over time

**Major Partnerships:** NASA Innovative Lunar Demonstration Data (ILDD) program (\$30M), Dynetics

**Headquarters** – Seattle, Washington USA

**Founded:** in 2010 as Arkyd Astronautics, reorganized and renamed in 2012.

**Co-Chairmen:** Pete Diamandis (ISU co-founder) and Eric Anderson (co-founder Space Adventures)

**Major Focus:** Mining asteroids: Water for fuel (in-space economy) and rare metals for Earth uses



**Implementation:** Series of small spacecraft with increasing capability. Initial space resource development will focus on water-rich asteroids

**Capacity:** N/A

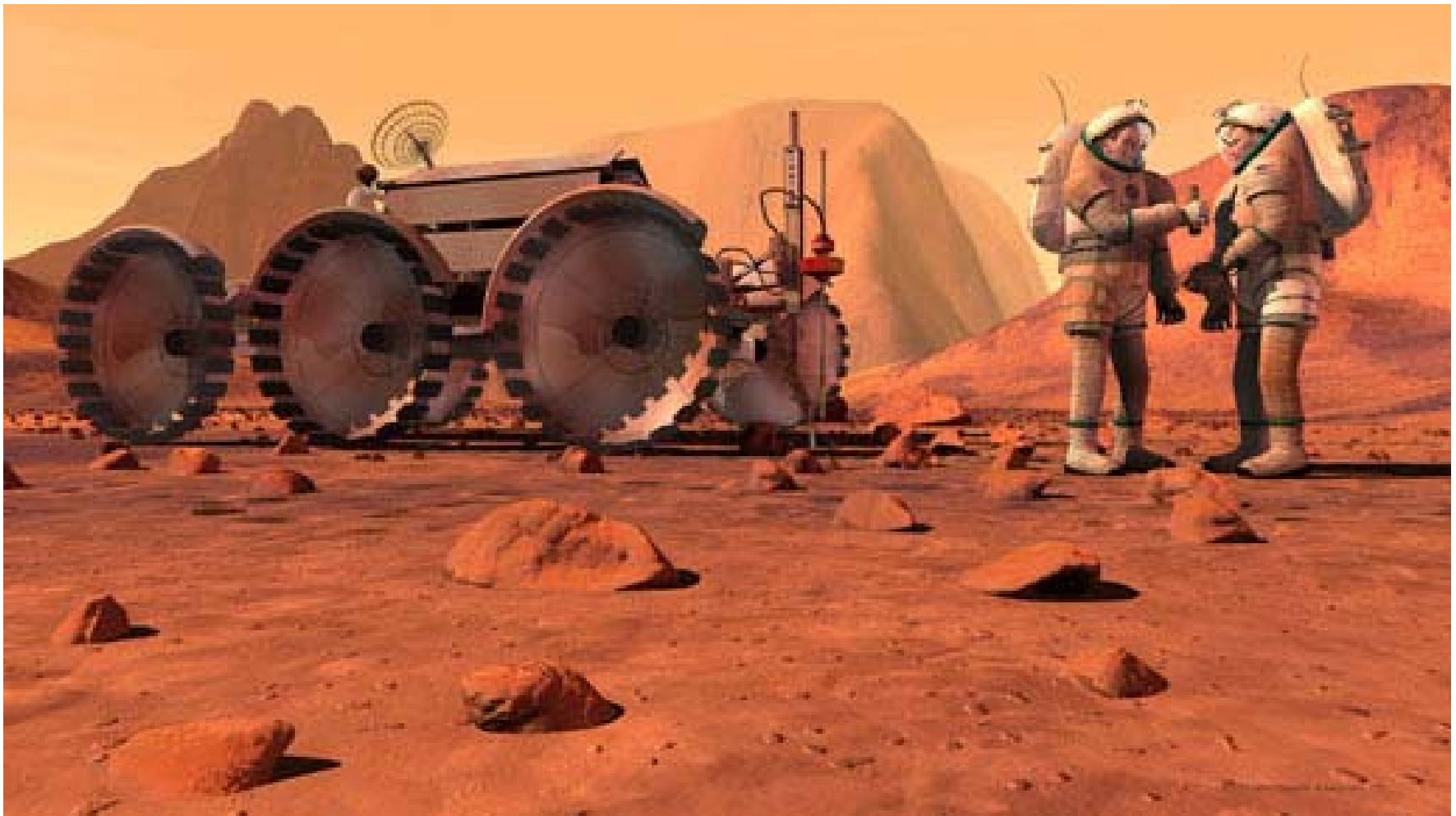
**Cost:** Unknown

**Major Partnerships:** Investors include; Larry Page and Eric Schmidt (Google) and Ross Perot, Jr

# Government's Role in Commercial Space

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- What should the role of government be in opening the space frontier?



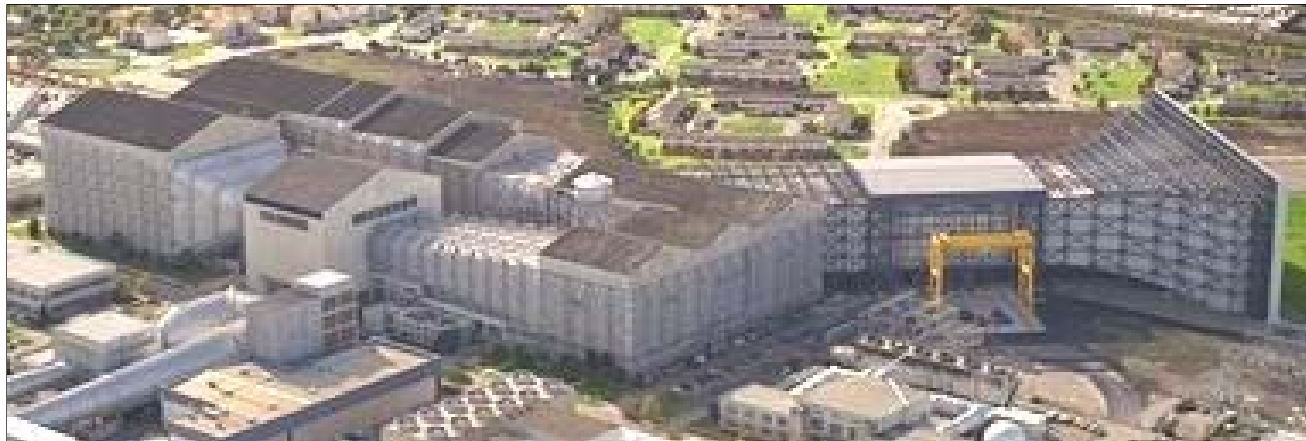
## Government's Role in Commercial Space

# National Advisory Committee for Aeronautics (NACA)

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- **Before NASA there was NACA:**
  - Established in 1915 by Congress
  - Developed key technologies to enabled air travel to become effective, economical and safe
  - Studied the problems of flight to identify and resolve risks that kept air travel from being safe and commercially viable
  - Government worked closely with industry to fund studies that retired technological risks and enabled private enterprise to successfully create a new industry





## Government's Role in Commercial Space Changes at NASA

<b>Program Characteristic</b>	<b>Early Space Age Approach</b>	<b>Commercial-Oriented Approach</b>
Owner	NASA	Industry
Contract Fee-Type	Cost Plus	Fixed Price
Contract Management	Prime Contractor	Public-Private Partnership
Customer(s)	NASA	Government and Non-Government
Funding for Capability Demonstration	NASA procures capability	NASA provides investment via milestone payments
NASA's Role in Capability Development	NASA defines "what" and "how"	NASA only defines "what" (Industry defines "how")
Requirements Definition	NASA defines detailed requirements	NASA defines top-level capabilities needed
Cost Structure	NASA incurs total cost	NASA and Industry cost share

# Government's Role in Commercial Space

## Commercial Crew Approach

### Traditional NASA Development

Goal: ISS Crew Mission

Extensive Government Involvement

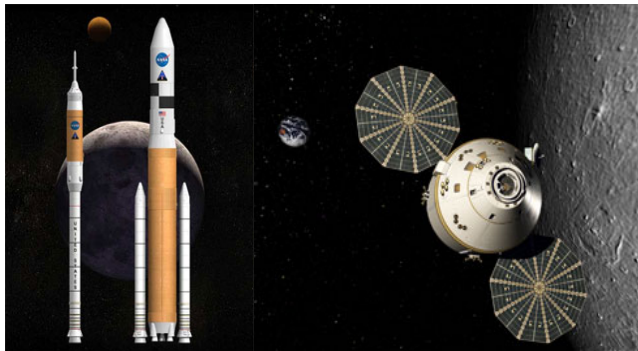
No Cost Sharing

Government Owns IP

Detailed Design Requirements

Unlimited Data and Lots of Deliverables

Higher Costs



### Non-Traditional Development

Goal: Commercial Human Transport

Limited Government Involvement

Cost Sharing

Commercial Partner Owns IP

Tailored Human-Rating Requirements

Pay-for-Performance Milestones

Lower Costs



**Government's Role in Commercial Space**  
**U.S. National Policy on Commercial Space**

(June 28, 2010)

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- Develop a robust and competitive U.S. commercial space sector
- Energize competitive domestic industries to participate in global markets
  - Purchase and use commercial space capabilities and services to the maximum practical extent
  - Actively explore the use of inventive, nontraditional arrangements for acquiring commercial space goods and services
  - Refrain from conducting U.S. Government space activities that preclude, discourage, or compete with U.S. commercial space activities
  - Pursue potential opportunities for transferring routine, operational space functions to the commercial space sector where beneficial and cost-effective.

## **Government's Role in Commercial Space**

# **U.S. Federal Aviation Administration (FAA)**

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- Created Office of Commercial Space Transportation
  - Regulate the commercial space transportation industry, only to the extent necessary
  - Encourage, facilitate, and promote commercial space launches by the private sector
  - Recommend appropriate changes in Federal statutes, treaties, regulations, policies, plans, and procedures;
  - Facilitate the strengthening and expansion of the U.S. space transportation infrastructure

# Government's Role in Commercial Space

## Why Commercial

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- **Why Commercial?**
  - Commercial companies must be competitive and governments have other priorities (safety, jobs, etc.)
  - Example: comparison of SpaceX to NASA Development Costs
    - NASA initial estimates using its normal cost estimating software for Falcon 9 were 10 times more expensive than SpaceX actuals
    - Even when NASA made adjustments its estimates were still 4 times more
- **Conflicting goals**
  - Congress focused on jobs in their districts
    - Sequestration hit commercial crew efforts

## NASA Programs to Stimulate Commercial Space - Updated

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- **Commercial Orbital Transportation Services (COTs) 2006**
  - NASA investment \$800M produced 2 new launchers 2 new ISS cargo carriers
- **Commercial Crew Development (CCDev) 2009 - 2011**
  - Stimulate development of privately operated crew vehicles
- **Commercial Crew Integrated Capability (CCiCap) 2012 - 2014**
  - Goals:
    - Advance multiple integrated crew transportation systems
    - Develop a Commercial Transportation System capability to LEO that supports a commercial market
- **Commercial Resupply Services**
  - 12 missions for SpaceX and 8 missions for Orbital Sciences (\$3.5B)
- **Flight Opportunities Program 2010 – Suborbital**
  - Commercial Reusable Suborbital Research Program (CRuSR) – support commercial suborbital spaceflight industry by providing a steady, guaranteed market for research payloads.
  - Facilitated Access to Space Technology (FAST) – funding for microgravity research

# Alternatives to Government Funding (New)

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- **Google Lunar X-Prize (GLXP) 2007 - 2015**
  - Eighteen teams currently in competition for \$30M in prizes
  - Land a robot on the Moon then travel more than 500m and transmits high definition images and video to Earth
- **NASA Innovative Lunar Demonstration Data - Indefinite delivery/indefinite quantity (IDIQ) contracts totaling up to \$30.1M**
  - Astrobotic Technology Inc., Pittsburgh, Pa.
  - The Charles Stark Draper Laboratory, Inc., Cambridge, Mass.
  - Dynetics Inc., Huntsville, Ala.
  - Earthrise Space Inc., Orlando, Fla.
  - Moon Express Inc., San Francisco
  - Team FREDNET, The Open Space Society, Inc., Huntsville, Ala.
- **Crowdfunding**
  - Kickstarter: Lunar Space Elevator (Liftport Group), CubeSat Ambipolar Thruster (CAT) (University of Michigan), Arkyd Telescope \$1.5M (Planetary Resources),...
  - Golden Spike Indiegogo campaign (\$240K wanted)



# Organizations Supporting New Space

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- **Students for the Exploration and Development of Space (SEDs)**

- 1980 founded by the same 3 founders as ISU, to promote space exploration and development.



- **National Space Society**

- 1987 promotes living in and working in space. The organization is located in many countries.



- **Space Frontier Foundation**

- 1988, dedicated to free enterprise and human settlement of the Solar System

- **Space Access Society**

- 1992, dedicated to reducing the cost for commercial access to space.



- **Commercial Spaceflight Federation**

- 2005, promotes commercial human spaceflight, high levels of safety, and shares best practices and expertise throughout the industry.



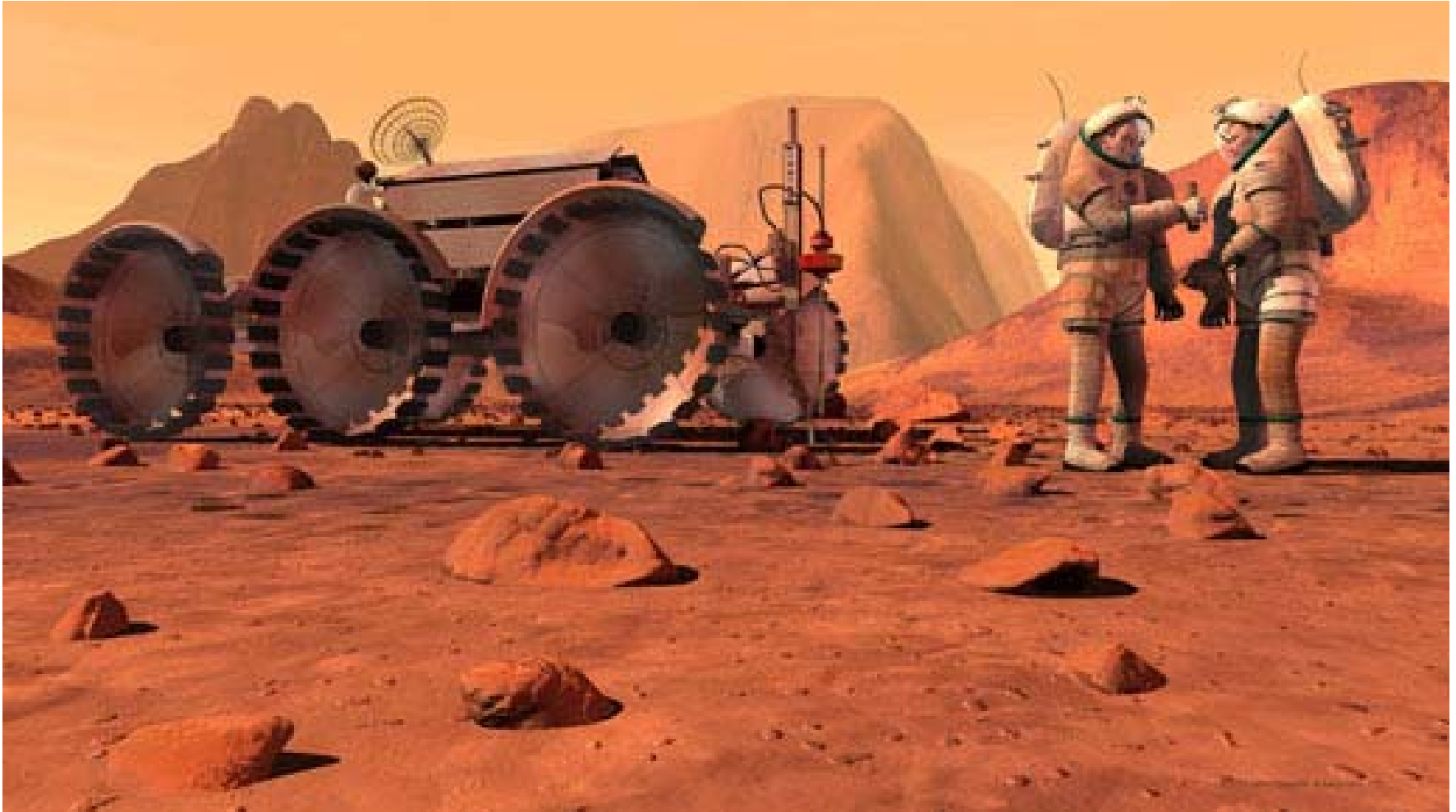
# Wrap Up

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- 1) You can now describe the different regimes where commercial space is starting to take hold
- 2) You can list some examples of areas where entrepreneurial companies are developing new markets
- 3) You can name a few companies that are examples of the commercial space revolution
- 4) You can discuss how governments can facilitate the birth of this new industry

# Back-Up

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# Technical and Policy Issues to Consider

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- **Outer Space Treaty - 1967**

- Precludes sovereignty over off-world territory by nations
- Principle of property rights in space is not clearly defined
- Most likely world governments would not recognize any claims of rights - serious risk that investments would be challenged under the current framework

- **Moon Treaty 1979**

- Not ratified by nations who could reach the Moon on their own
- Bans any ownership of any extraterrestrial property by any organization or person, unless that organization is international and governmental.
- Requires all resource extraction and allocation be made by an international regime.

## Current Areas of Commercial Space Development

# Orbital Cargo Transportation

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- **SpaceX – Falcon 9 rocket and Dragon spacecraft**
  - Cargo - \$396M NASA investment
  - 12 Commercial Resupply Services (CRS) flights to ISS, valued at \$1.6 billion
  - May 2012 – Successfully demonstrated docking at ISS
  - October 2012 – CCIcap, First successful commercial resupply to ISS
  - March 1, 2013 – Second flight to ISS planned
- **Orbital Sciences - Antares rocket and Cygnus spacecraft**
  - Cargo - \$288M NASA investment
  - 8 CRS flights to ISS, valued at \$1.9 billion



## Current Areas of Commercial Space Development

# Orbital Crew Transportation

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- **SpaceX – Falcon 9 rocket and Dragon spacecraft**
  - \$75M NASA (CCDev2) Award
  - \$440M NASA (CCiCAP) Award
- **Sierra Nevada Corporation – Atlas V rocket and Dream Chaser spacecraft**
  - \$106M NASA (CCDev2) Award
  - \$212.5M NASA (CCiCAP) Award
- **Boeing – CST-100 Spacecraft – Atlas V rocket and CST-100 spacecraft**
  - \$113M NASA (CCDev2) Award
  - \$460M NASA (CCiCAP) Award
- **Blue Origin –**
  - \$22M NASA (CCDev2) Award
  - No NASA (CCiCAP) Award



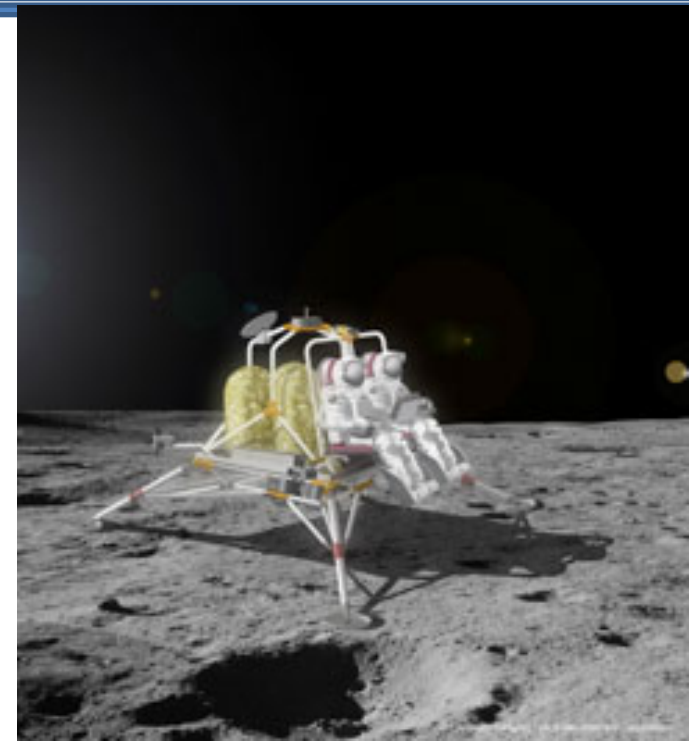
## Deep Space Golden Spike

**Headquarters** – Colorado USA

**Founded:** 2010 Alan Stern, President and CEO, (former NASA Science AA)

**Major Focus:** Human transportation to the Moon, Science, Commerce, Tourism, Entertainment, Engagement, and Education.

**Implementation:** Use existing launchers (possibly SpaceX) and create new lander. Automated trips to Moon managed from Earth.



**Capacity:** 2 people

**Cost:** \$1.5B for trip to Moon and back  
(\$750M each seat)

**Major Partnerships:** Northrup Grumman  
and Armadillo



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