



# NewSpace:

The Emerging Commercial Space  
Industry

ISU MSS 2017

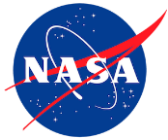
Gary Martin  
Director of Partnerships  
NASA Ames Research Center



## LEARNING OUTCOMES

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

- 1) Describe the areas in which entrepreneurial companies are developing new markets
- 2) Name a few companies that are examples of the commercial space revolution
- 3) Discuss how governments and private investments can facilitate the birth of this new industry



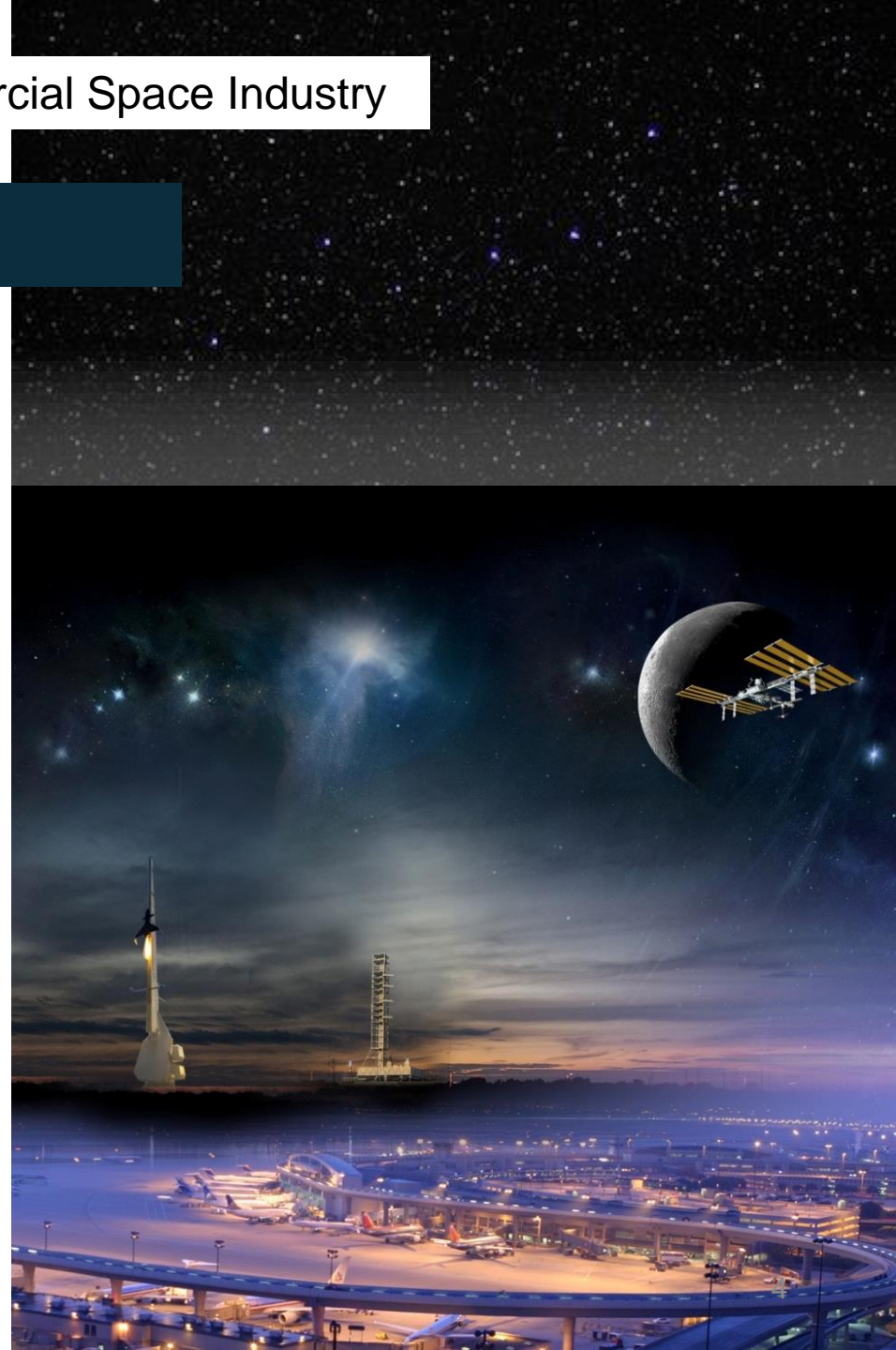
## WHY IS THIS LECTURE IMPORTANT?

- 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 non-traditional ways
- The established state run industrial space sector is no longer the only game in town
- Increased competition and new capabilities will change the space frontier forever
- Everyone interested in working in the space sector will be effected



## OUTLINE

1. Regimes for NewSpace Opportunities
  - Suborbital
  - Orbital
  - Deep Space
2. Example NewSpace Companies
3. The Role of Government
4. The Role of Private Industry







## WHAT IS NEWSPACE?

### From Wikipedia:

*"NewSpace—formerly **alt.space**; also "new space,"<sup>[1][2]</sup> **entrepreneurial space**, and "commercial space"<sup>[3][4][5][6]</sup>—are umbrella terms for a [movement](#) and [philosophy](#)<sup>[7]</sup> encompassing, but substantially broader than, an emergent, somewhat more visible and defined, [private spaceflight](#) industry. Specifically, the terms are used to refer to a community of relatively new aerospace companies working to independently (of governments and their prime/major contractors, i.e., Old Space) develop faster, better, and cheaper access to space, space and spaceflight technologies, and space missions, as a threshold matter; and designers and advocates of such underlying space and spaceflight concepts, architectures, systems, technologies, missions, programs, protocols, and policies."*

#### References

1. Hutchinson, Lee (2014-11-30). "[Firefly Space Systems charges full-speed toward low Earth orbit](#)". *ars Technica*. Retrieved 2014-12-01.
2. Achenbach, Joel (2013-11-23). "[Which way to space? Flights of fancy may launch the industry's future](#)". *washingtonpost.com*. *The Washington Post*. Retrieved 2016-11-18.
3. Martin, Gary (2016-01-25). "[NewSpace: The "Emerging" Commercial Space Industry](#)" (PDF). *nasa.gov*. NASA. Retrieved 2016-09-16.
4. "[Bachelor of Science in Commercial Space Operations](#)". Embry-Riddle Aeronautical University (Bachelor's Programs). Embry-Riddle Aeronautical University (Daytona Beach, Florida). Retrieved 2016-09-08.
5. David Anderman. "[The New Commercial Space Companies](#)". *Web.archive.org*. Archived from [the original](#) on 13 August 2006. Retrieved 2014-02-06.
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## 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:

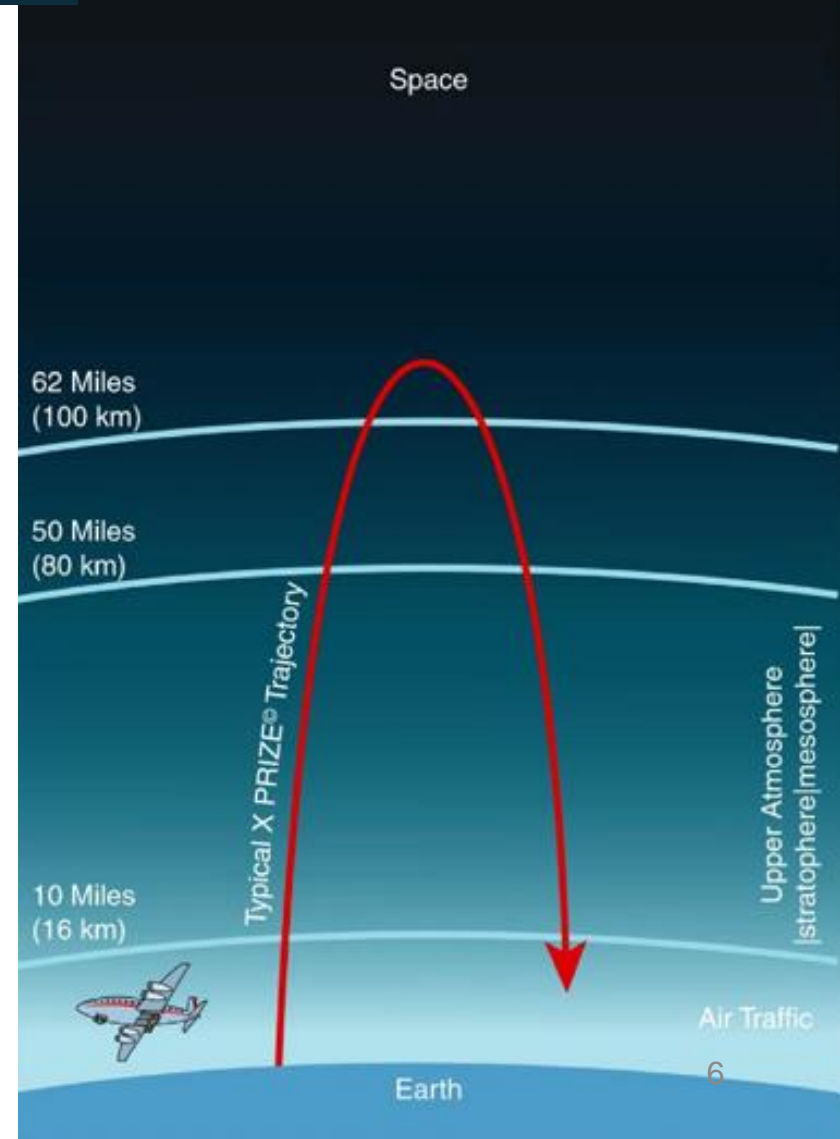
- Companies selling tickets for the suborbital experience from \$250K (Virgin Galactic) to \$150K (XCOR) per seat

### 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) 180 – 3000km
- High Earth Orbit (HEO) – Geocentric 35,786km

### Tourist Industry:

- Provides long periods of time in microgravity at ISS or on private space stations
- Space Adventures: 7 private citizens to ISS (8 missions – \$20M-\$52M per trip)

### Research/Applications:

- Conduct experiments continuously in the orbital environment (microgravity and life sciences)
- Produce commercial products
- Launch small spacecraft from ISS

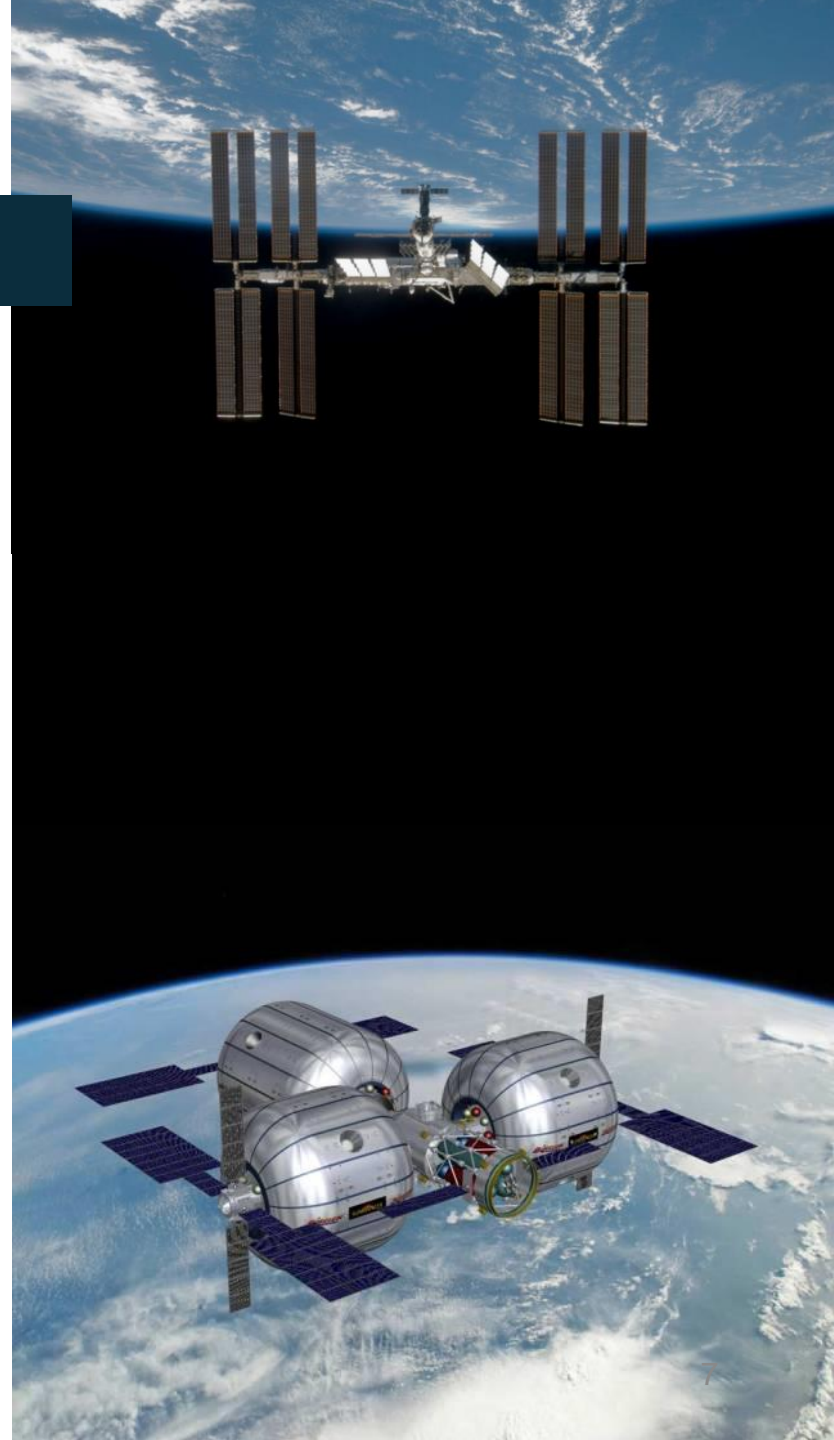
### Satellite Servicing:

- Service satellites, put them in proper orbits, refuel, fix and upgrade systems

### Earth Imaging:

- Natural resources, site development, crop monitoring, asset management...

### Broadband:





## DEEP SPACE

### Description:

- Lagrange points, Moon, Asteroids, Mars and beyond

### Tourist Industry:

- Ultimate in exotic experiences, Lunar and Mars

### 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:

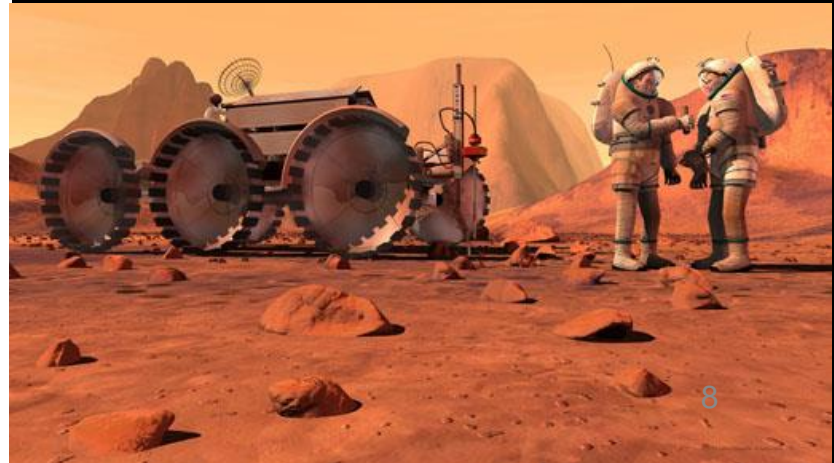
- Examples: Propellants, metal & materials processing, and building materials

### Servicing a space-based economy:

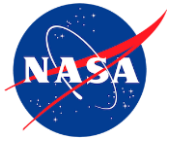
- Examples: 3D printing in space, space manufacturing

### Settlement:

- Moving human civilization to Moon and Mars







## Examples of NewSpace Companies

### SUBORBITAL, ORBITAL



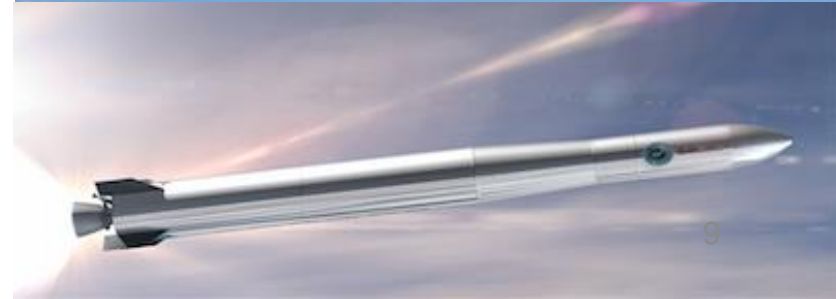
**HQ:** Las Cruces, New Mexico

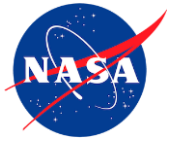
**Founded:** 2004 Richard Branson (Virgin Group)

**Focus:** Space Tourism & Research; Low-cost small satellite launch

**Cost:** \$250K per seat, \$10M per satellite

**Major Partnerships:** Spaceport America in New Mexico, Y3, and, Landrover





## SUBORBITAL and ORBITAL



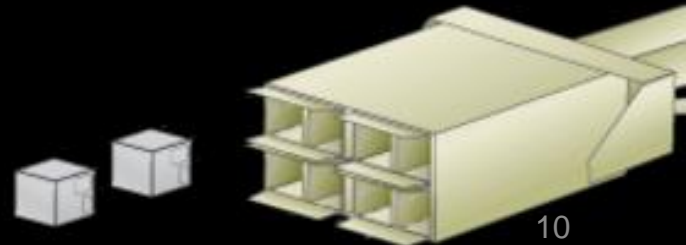
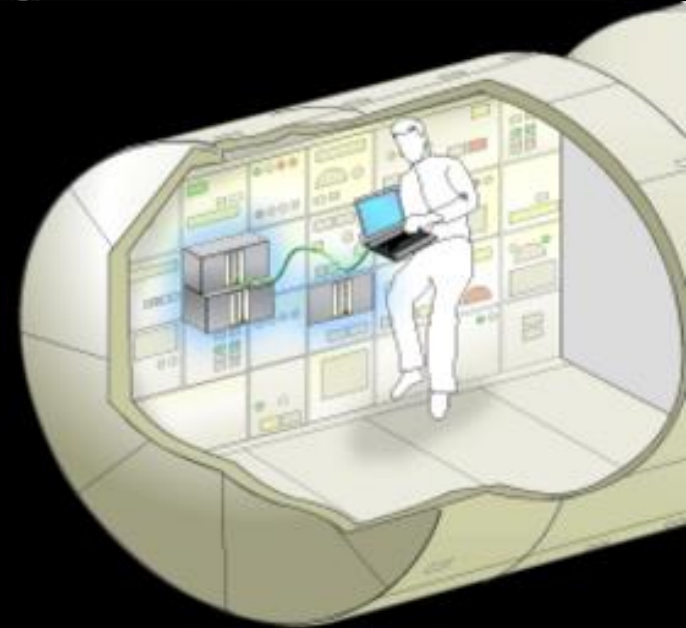
**HQ:** Houston, TX

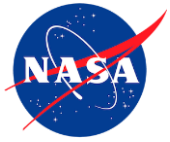
**Founded:** 2009 CEO Jeff Manber (MirCorp)

**Focus:** Sub-orbital (Blue Origins); On-orbit (and beyond) research and smallsat launch, ISS internal and external, and beyond

**Cost:** Variable based on hardware and services needed. Internal educational payloads start at \$15K, deployment starts at \$85,000 (1U CubeSat)

**Major Partnerships:** XCOR, Astrium, Schafer, Spaceflight Services, Ardulab, GOMspace, and Student S/F Exp. Program





# Examples of NewSpace Companies

## ORBITAL



**HQ:** San Francisco, California

**Founded:** 2010 Will Marshall, Robbie Schingler, Chris Boshuizen

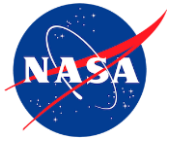
**Focus:** Applications, Earth Sensing

**Capacity:** Launched over 179 smallsats, resolution (145 made it to orbit); 10 square feet resolution

**Major Partnerships:** Raised \$183M in 5 years







# Examples of NewSpace Companies

## ORBITAL



**HQ:** North Las Vegas, NV

**Founded:** 1998 by Robert Bigelow

**Focus:** Orbital stations

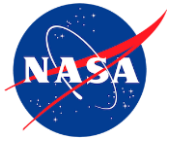
**Capacity:** BEAM 16m<sup>3</sup> on ISS; BA330 has 330m<sup>3</sup> of internal space

**Cost:** \$25M for 110m<sup>3</sup> for 60 days (1/3 of BA330)

**Major Partnerships:** NASA, SpaceX, Boeing, ULA







## Examples of NewSpace Companies

### ORBITAL, DEEP SPACE

# SPACEX

**HQ:** Hawthorne, California

**Founded:** 2002 Elon Musk

**Focus:** Reusable transport to Low Earth Orbit (ISS), Geostationary Transfer Orbit (GTO), Mars

**Cost:** \$62M Falcon 9 Full Thrust; Falcon Heavy \$90M for 8mt to GTO

**Major Partnerships:** NASA Commercial Crew





# Examples of NewSpace Companies

## DEEP SPACE



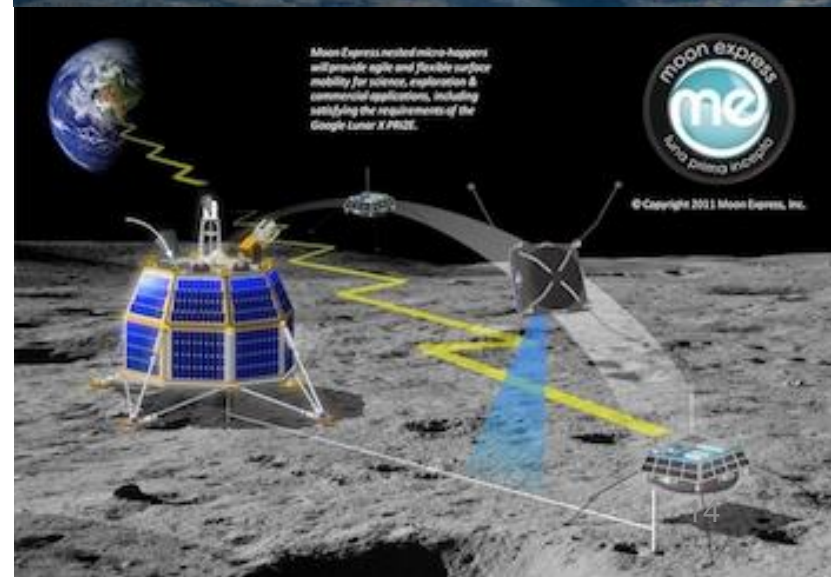
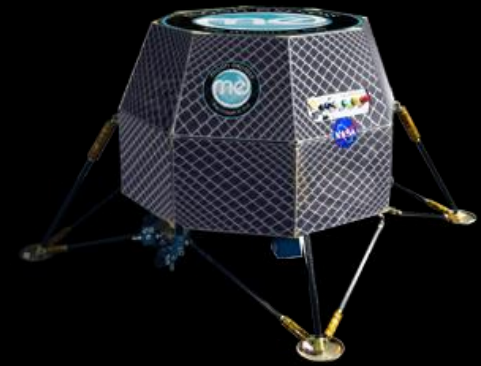
**HQ:** Moved to NASA KSC, Florida

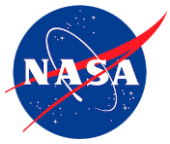
**Founded:** 2010 Bob Richards, Andy Aldrin

**Focus:** Lunar payloads, resource exploration, Google Lunar X Prize.

**Cost:** Initial cost ~\$3M/kg

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





## Examples of NewSpace Companies

### DEEP SPACE



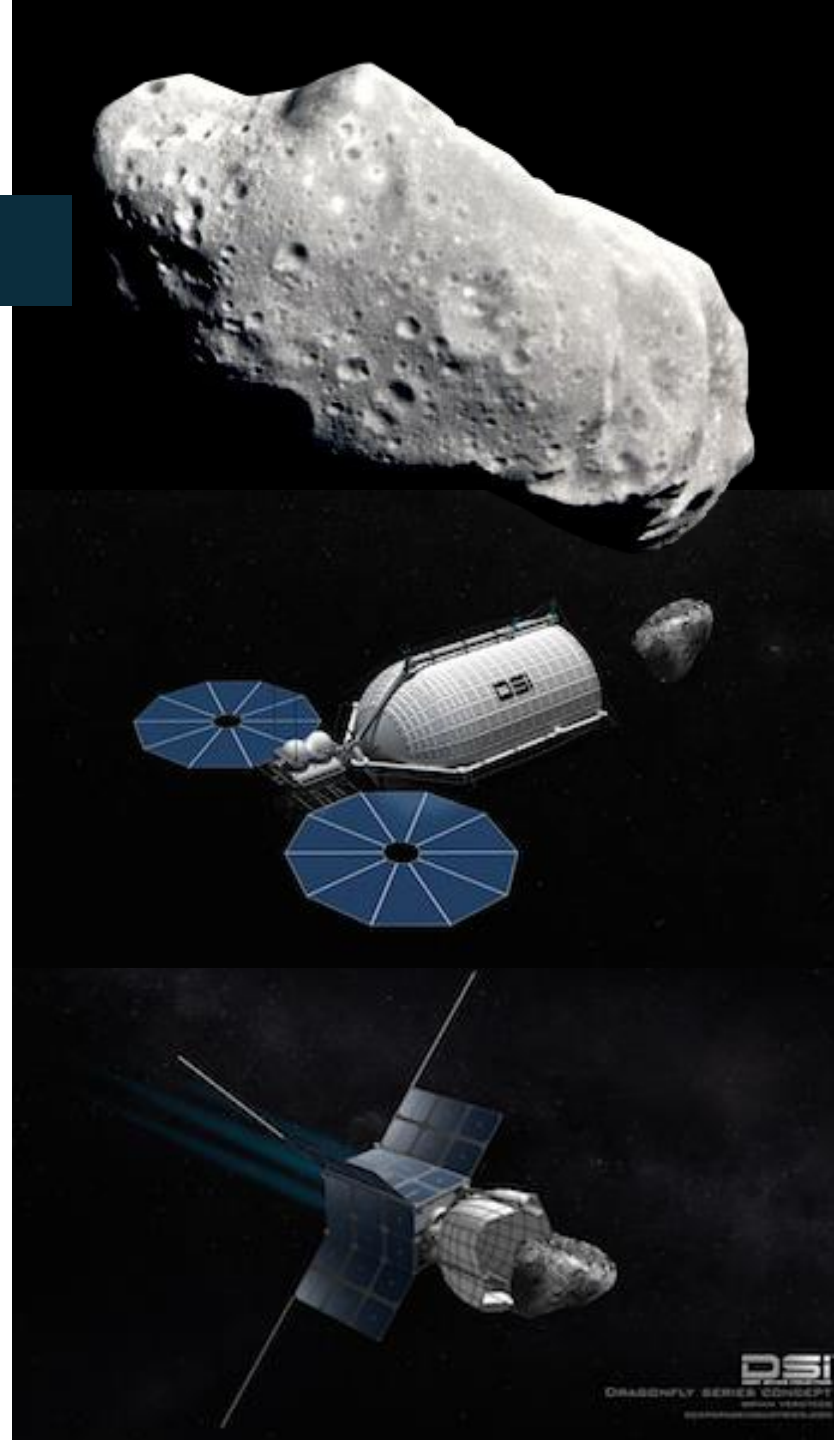
**HQ:** Mountain View, CA

**Founded:** 2013, Rick N. Tumlinson, Daniel Faber, David Gump et al.

**Focus:** Asteroid Mining: Water & Rare Metals

**Implementation:** Prospector X – tech demo, Prospector 1 – mining demo

**Major Partnerships:** Luxembourg, NASA Asteroid Redirect Mission



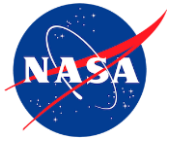


## The Government's Role in Commercializing Space

Key question:

“What role should the government play in the commercialization of space?”

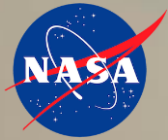




## NATIONAL ADVISORY COUNCIL FOR AERONAUTICS (NACA)

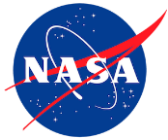
- Established in 1915 by Congress
- Developed key technologies to **enabled air travel** to become effective, economical and safe
- Studied the problems of flight to **identify and resolve risks** that kept air travel from being **safe and commercially viable**
- Government **worked closely with industry**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





## 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 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 share cost



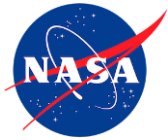
## US NATIONAL POLICY ON COMMERCIAL SPACE

**“Develop a robust and competitive U.S. commercial space sector”**

**&**

**“Energize competitive domestic industries to participate in global markets”**

– NASA Act (as amended  
June 28, 2010)



## US NATIONAL POLICY ON COMMERCIAL SPACE

### NASA is to achieve this by:

- Purchasing and using **commercial space capabilities** and services to the maximum practical extent
- Actively exploring the use of **inventive, nontraditional arrangements** for acquiring commercial space goods and services
- **Refraining from** conducting U.S. Government space **activities that preclude, discourage, or compete with U.S. commercial space activities**
- Pursuing potential opportunities for **transferring routine, operational space functions to the commercial space sector** where beneficial and cost-effective.

June 28, 2010

A handwritten signature in brown ink, appearing to read "George", written in a cursive style.



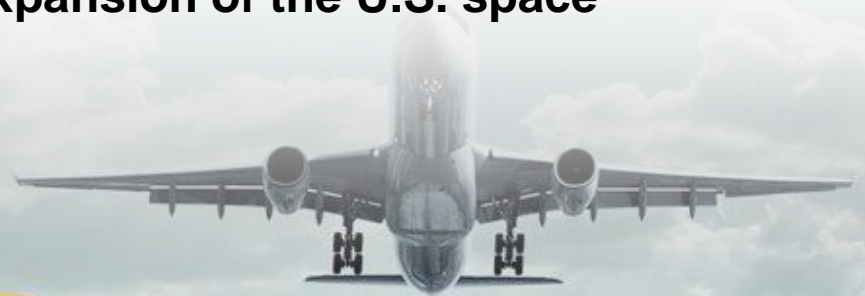


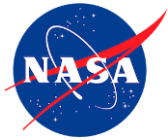
## FAA Office of Commercial Space Transportation

### Founded 1984, to:

- **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**

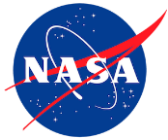
FAA





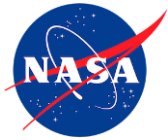
## WHY COMMERCIAL?

- **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**
  - US Congress focused on jobs in their districts



## NASA PROGRAMS TO STIMULATE COMMERCIAL SPACE

- **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**
  - Advance multiple integrated crew transportation systems to LEO
- **Commercial Resupply Services (CRS-1) 2008 - present**
  - 20 missions for SpaceX and 10 missions for Orbital Sciences
- **Commercial Resupply Services (CRS-2) 2019 - 2024**
  - 6 missions each for SpaceX, Orbital Sciences and Sierra Nevada Corporation
- **Collaborations for Commercial Space Capabilities – SAAs**
  - Advance private sector development of emerging products and services commercially available to government and non-government customers
- **Flight Opportunities Program 2010 – present; Suborbital**
  - Commercial Reusable Suborbital Research Program (CRuSR) – supports commercial suborbital spaceflight by providing a steady, guaranteed market for research payloads
  - Facilitated Access to Space Technology (FAST) – funding microgravity research



## ALTERNATIVES TO GOVERNMENT FUNDING

### **Google Lunar X-Prize (GLXP) 2007 - 2016**

- 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

### **Crowdfunding**

- Kickstarter: Lunar Space Elevator (Liftport Group), CubeSat Ambipolar Thruster (CAT) (UMich), Arkyd Telescope \$1.5M (Planetary Resources) etc.
  - Spire





## NEWSPACE INVESTMENTS (NSG 50)

### \$200M-\$2B

SpaceX  
Virgin Galactic\*  
Blue Origin\*  
Vulcan Aerospace\*  
O3B  
OneWeb  
Planet Labs  
Cloudera

Crunchbase Data 2015

### \$20M-\$200M

Skybox  
Spaceflight Industries  
MapBox  
Spire  
Moon Express  
SpaceIL  
Kymeta

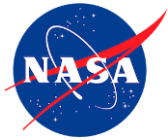
(\*) SVSC estimates

### \$2M-\$20M

Dauria Aerospace  
Planetary Resources  
OmniEarth  
Satellogic  
Astroscale  
Nanoracks  
XCOR  
Rocket Lab  
Firefly  
Reaction Engines  
Accion Systems  
Orbital Insight  
ClearStory Data  
SpaceKnow

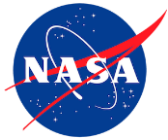
Source: Sean Casey (SVSC)

**From 2005-2015 \$12B in private investment** Source: Silicon Valley Space Center



### NEWSPACE INVESTMENTS - Luxembourg

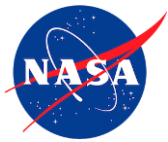
- The Luxembourg Government announced a series of measures to position Luxembourg as a European hub in the exploration and use of space resources (February 3, 2016).
- Luxembourg will develop a legal and regulatory framework confirming certainty about the future ownership of minerals extracted in space from Near Earth Objects (NEO's) such as asteroids.
- Opening a €200 million (\$225 million) line of credit for entrepreneurial space companies to set up their European headquarters within its borders (June 3, 2016).



## WRAP UP

### **You should be able to:**

- 1) List some examples of areas where entrepreneurial companies are developing new markets;
- 2) Name a few companies that are examples of the commercial space revolution;
- 3) Discuss how governments and private industry can facilitate the birth of this new industry; and



## ORGANIZATIONS PROMOTING NEWSPACE



### **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.





## REFERENCES

- Page 1: Front Page: SpaceX image: Lazarus Luan: <http://forum.kerbalspaceprogram.com/index.php?/topic/27154-090-laztek-spacex-launch-exploration-colonial-transporter-amp-historic-mods-12514/> and Virgin image: <http://www.futuretravelexperience.com/2013/12/virgin-galactic-we-want-to-take-long-haul-air-travel-above-the-atmosphere/> and Bigelow image: <http://www.spaceref.com/news/viewpr.html?pid=31881> and DSI image: <http://www.space.com/19378-deep-space-industries-asteroid-mining-photos.html>
- Page 5: NewSpace definition: <http://en.wikipedia.org/wiki/NewSpace>
- Page 6: Research areas - Next Generation Suborbital Researchers Conference 2013; <http://www.boulder.swri.edu/NSRC2013/Site2/Home2013.html> , and diagram: [http://www.spacefuture.com/archive/flight\\_mechanics\\_of\\_manned\\_suborbital\\_reusable\\_launch\\_vehicles\\_with\\_recommendations\\_for\\_launch\\_and\\_recovery.shtml](http://www.spacefuture.com/archive/flight_mechanics_of_manned_suborbital_reusable_launch_vehicles_with_recommendations_for_launch_and_recovery.shtml); XCOR ticket cost: <http://www.xcor.com/news/ticket-price-change/>; Virgin ticket cost: <http://www.space.com/20886-virgin-galactic-spaceshiptwo-ticket-prices.html>
- Page 7: Orbital: [http://en.wikipedia.org/wiki/Space\\_tourism](http://en.wikipedia.org/wiki/Space_tourism) , ISS: NASA image, Bigelow Space Station: <http://meflyrocket.wordpress.com/2011/03/17/the-future-of-commercial-spaceflight-and-space-tourism/>; Cost for Space Adventures; [https://en.wikipedia.org/wiki/Space\\_Adventures](https://en.wikipedia.org/wiki/Space_Adventures)
- Page 8: [http://www.esa.int/Our\\_Activities/Technology/Building\\_a\\_lunar\\_base\\_with\\_3D\\_printing](http://www.esa.int/Our_Activities/Technology/Building_a_lunar_base_with_3D_printing) and two NASA Images.
- Page 9: Virgin Galactic: <http://www.virgingalactic.com/> and [http://en.wikipedia.org/wiki/Virgin\\_Galactic](http://en.wikipedia.org/wiki/Virgin_Galactic) and <http://www.forbes.com/sites/michaelvenables/2013/02/08/interview-steve-isakowitz/> and <http://www.virgingalactic.com/satellite-launch/l1-operations/> and <http://www.virgingalactic.com/partners/>
- Page 10: Nanoracks: <http://nanoracks.com/> and <http://nanoracks.com/products/> and [http://nanoracks.com/wp-content/uploads/NanoRacks\\_CubeSat\\_Deployment.jpg](http://nanoracks.com/wp-content/uploads/NanoRacks_CubeSat_Deployment.jpg) and <http://nanoracks.com/resources/faq/>
- Page 11: Planet Labs: <http://www.planet.com/>; Lurio Report 2014; <http://techcrunch.com/2015/01/20/planet-labs-95m/> and <https://www.planet.com/flock1/> and <https://www.planet.com/gallery/>





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- Page 12: Bigelow Aerospace: <http://www.bigelowaerospace.com/> and <http://bigelowaerospace.com/b330/> and <https://bigelowaerospace.com/about#strategic>
- Page 13: SpaceX: <http://www.spacex.com/> and <http://spacenews.com/spacexs-new-price-chart-illustrates-performance-cost-of-reusability/>  
<http://www.space.com/30888-spacex-dragon-enters-mars-atmosphere.html>
- Page 14: Moon Express: <http://www.moonexpress.com/> and discussions Bob Richards and <http://www.moonexpress.com/missions.html> and [http://www.moonexpress.com/missions\\_payload.html](http://www.moonexpress.com/missions_payload.html)
- Page 15: Deep Space Industries [deepspaceindustries.com/blog/](http://deepspaceindustries.com/blog/) and [www.deepspaceindustries.com/daniel-faber-ceo-of-dsi-to-moderate-panel-at-sxsw/](http://www.deepspaceindustries.com/daniel-faber-ceo-of-dsi-to-moderate-panel-at-sxsw/) and [www.deepspaceindustries.com/space-resources/](http://www.deepspaceindustries.com/space-resources/), <https://deepspaceindustries.com/>
- Page 17: NACA: <http://history.nasa.gov/SP-4406/chap1.html>
- Page 18: NASA HQ Presentation 2014: 'Why Commercial Space and Why are we doing it'; Phil McAlister HEOMD
- Page 19-20: Space Policy: <http://www.space.commerce.gov/general/nationalspacepolicy/>
- Page 21: FAA Policy: [http://www.faa.gov/about/office\\_org/headquarters\\_offices/ast/about/](http://www.faa.gov/about/office_org/headquarters_offices/ast/about/)
- Page 23: Developing Cislunar Space Using the COTS Model, White Paper by Bruce Pittman & Dr. Daniel J. Rasky
- Page 24: Flight Opportunities: <https://flightopportunities.nasa.gov/> and Commercial Certification Process and Accomplishments, Nov 15, 2012, NAC Meeting, Phil MacAlister; CCDev Status January 2013 (video): <http://www.youtube.com/watch?v=lvVdD6qqROM>
- Page 25: NewSpace Investments: Sean Casey (Silicon Valley Space Center) from crunchbase.com
- Page 26 Luxembourg and Space Resources: <http://www.spaceresources.public.lu/en/index.html> and <http://arstechnica.com/science/2016/06/luxembourg-wants-to-become-the-silicon-valley-of-asteroid-mining/>
- Page 28: Commercial Spaceflight Federation <http://www.commercialspaceflight.org/> ; National Space Society <http://www.nss.org/> ; Space Access Society <http://www.space-access.org/> Students for the Exploration and Development of Space <http://seds.org/> ; Space Frontier Foundation <http://spacefrontier.org/>