



Venture Space in the U.S.

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Presentation to:
National Space Policy Secretariat
Cabinet Affairs Office
30 July 2020



Introduction – Background on a changing U.S. space sector

- The status of commercial space activity globally is changing; today I will focus on the U.S.
- This will not be a detailed analysis, but rather a general overview of the venture space market in the U.S.
- Large aerospace still leads, but smaller firms, backed by venture capital or personal wealth, will drive the future.
- The U.S. has always had commercial involvement in space, but several factors are driving the current shift
 - Technical innovation leads to smaller and cheaper options – cubesats and dedicated launch vehicles
 - Innovative funding concepts excite new entrants – X prize as a catalyst
 - Billionaire founders inspire other entrepreneurs – Musk, Bezos, Branson as inspiration
 - Government support – Space Policy Directives; Commercial Crew and Cargo; Commercial Lunar Payload
- Venture space is vibrant in the U.S.
 - Strong support for entrepreneurship; willingness to let ventures fail
 - Recognition that venture space will drive future innovation
 - Hundreds of venture space companies formed in the U.S. in the last ten years

Topics for today



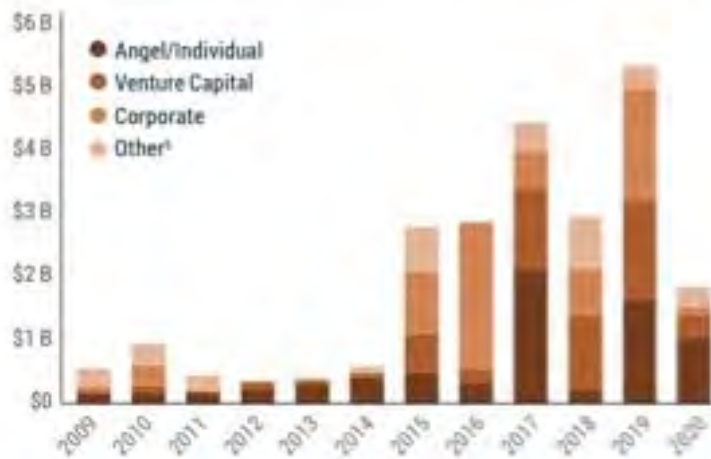
- Current investment outlook for venture space in the U.S.
- Why is there a strong interest in space investment?
- Top-level assessment of space industry sectors
 - Launch Vehicles
 - Communications Satellites
 - Lunar exploration
 - Human space flight
 - On orbit servicing
- Impact of COVID-19 on venture space sector
- Factors that will lead to successful and growing space market
- Space industry in 2050

Investment Outlook

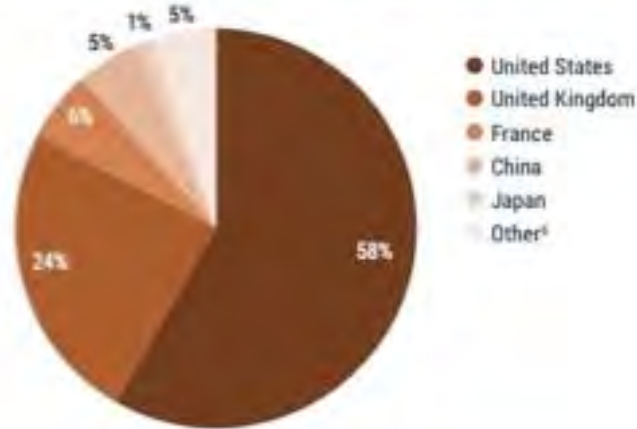
Global equity investment in space is rapidly increasing



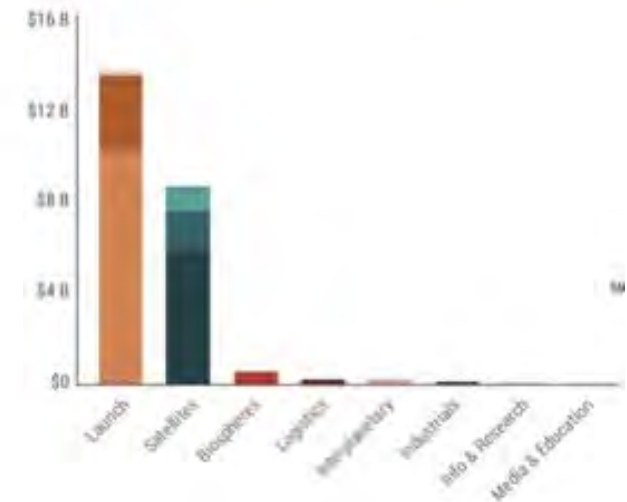
ANNUAL INVESTMENT SOURCE



CUMULATIVE INVESTMENT GEOGRAPHY



BY SECTOR² - CUMULATIVE INVESTMENT AMOUNT



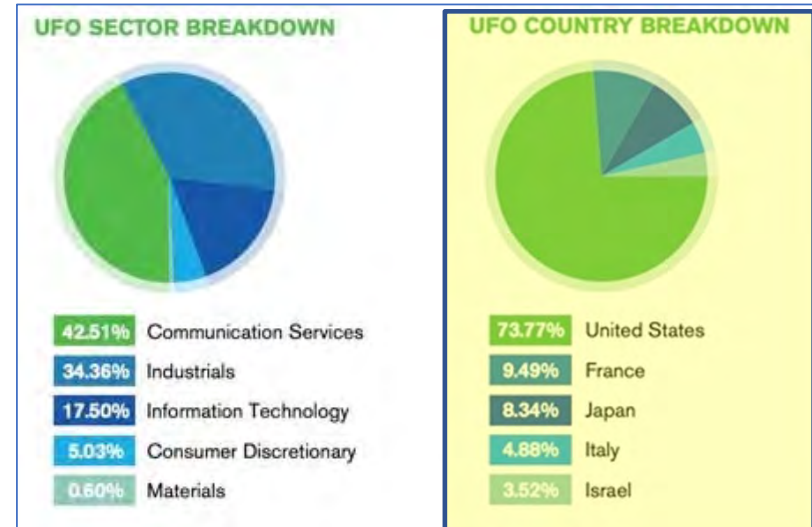
- Total investment since 2009 = \$23B
- Total number of companies invested in since 2009 = 360
- Investment in Launch, Satellites is vast majority of overall space investment
- Investment from US and UK ventures is >80%
- Number of exits and proven business cases is still low

Space Angels, Q2 2020



Space ETF traded on NASDAQ (UFO)

SecurityName	Weightings
VIRGIN GALACTIC HOLDINGS INC COM	7.74%
MAXAR TECHNOLOGIES INC	5.33%
IRIDIUM COMMUNICATIONS INC	5.12%
TRIMBLE INC	4.94%
ORBCOMM INC	4.91%
DISH NETWORK CORPORATION	4.88%
GARMIN LTD	4.87%
WEATHERNEWS INC	4.64%
SIRIUS XM HOLDINGS INC	4.64%
SES SA	4.61%
LORAL SPACE & COMMUNICATNS INC COM	4.55%
AVIO SPA	4.54%
VIASAT INC	4.33%
SKY PERFECT JSAT H	4.31%
EUTELSAT COMMUNICA	4.24%
EHOSTAR CORP	4.12%
GILAT SATELLITE NETWORKS LTD SHS NEW	2.79%
COMCAST CORP NEW	2.55%
BOEING CO	2.35%
LOCKHEED MARTIN CORP	2.31%
AT&T INC	2.26%
RAYTHEON TECHNOLOGIES CORP	2.23%
NORTHROP GRUMMAN CORP	2.22%
L3HARRIS TECHNOLOGIES INC	2.01%
HONEYWELL INTL INC	1.47%
AIRBUS GROUP SE	0.72%
BALL CORP	0.61%
Cash & Other	0.29%
AEROJET ROCKETDYNE HLDGS INC COM	0.20%
THALES	0.14%
LEONARDO-FINMECCANICA SPA	0.05%
IHI CORPORATION	0.01%



Why is there a strong interest in venture space?

Utilization – Our daily lives are reliant on satellites



We need data and information from space more than ever



TRAFFIC MANAGEMENT



WEATHER FORECASTING



BROADCASTING



DISASTER MANAGEMENT



EARTH OBSERVATION



NAVIGATION / LOGISTICS



TIME STAMPS (FINANCE)



INTERNET OF THINGS

Exploration – International push for next steps



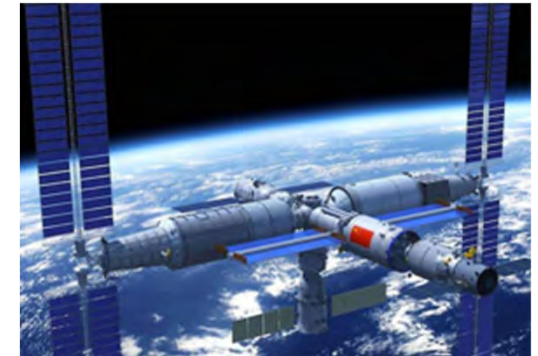
More countries (geopolitical reasons) and more companies (economic reasons) are developing plans for space exploration



SpaceX Mars Base



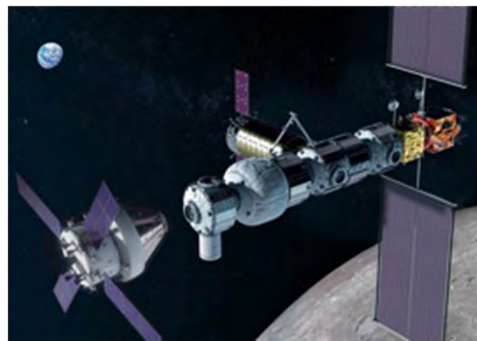
iSpace Moon Valley 2040



China Space Station



ESA Moon Village



NASA Lunar Gateway

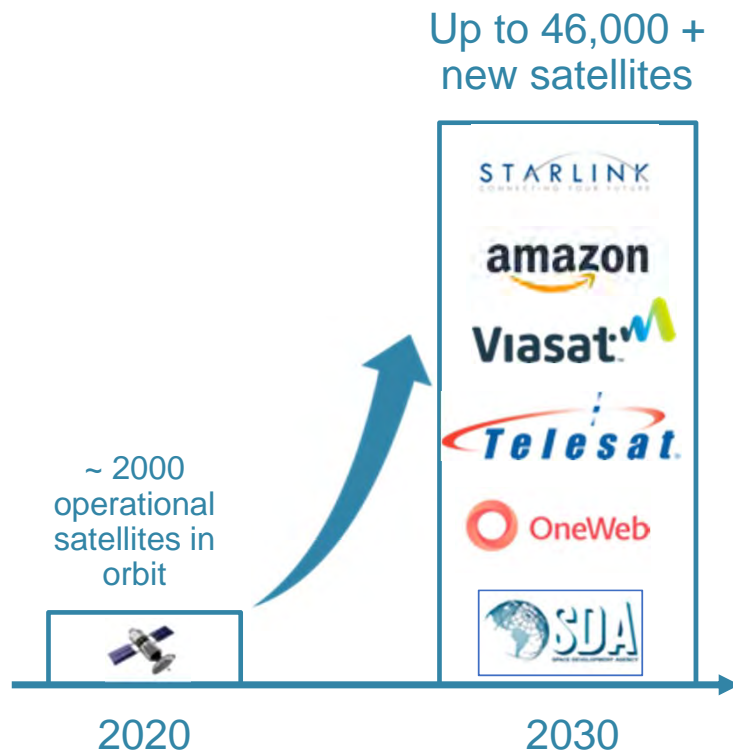


Axiom Space Station

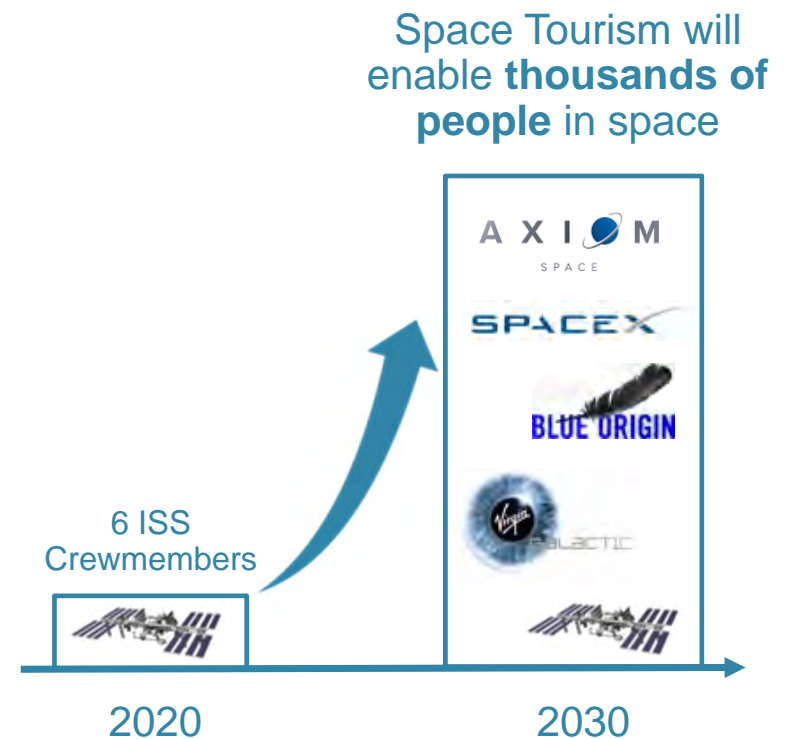
Sustainability - Space is more congested, safety is essential



Uncrewed Spacecraft



Crewed Spacecraft



Market Sectors

Market sector – Launch vehicles



- This is a small sample of multiple venture launch vehicle companies being formed
- Many other companies are in development stage but these are the leading competitors for now
- Reusability will be key to lowering costs

Heavy to Super Heavy
 Mass: 6 tons to >30 tons
 Cost: ~\$2000/kg launch cost

Small to Mid
 Mass: 500 kg to 6 tons
 Cost: ~\$10,000/kg launch cost

Small, Dedicated
 Mass: >500 kg
 Cost: ~\$35,000/kg launch cost



Relativity



Lower cost but less freedom
 → city bus



Higher cost but more freedom
 → taxi

Market sector – LEO Communications



- Iridium – 82 operational satellites
- SpaceX – 540 operational satellites (plans to launch up to 42,000)
- OneWeb – 6 operational satellites (plans to launch up to 2,000)
- Uncertainty around OneWeb acquisition by UK Government; likely to continue to manufacture in US for first generation
- SDA is the first government agency to express plans for a LEO communications and tracking constellation; expands the potential for market development
- Continued questions about revenue stream in light of OneWeb issues and complicated political questions such as landing rights.



Market sector – Earth observation



- Maxar/DigitalGlobe – 5 operational satellites; market leader in terms of revenue and image quality
- Planet – >150 operational satellites –agriculture, government, and commercial mapping for many industries
- Spire – >80 operational satellites –shipping and maritime customers
- BlackSky – 4 operational satellites; plans to launch up to 16 more in next several years
- BlackJack – planned 20 satellite constellation beginning launch in 2021; US DOD (DARPA) constellation that would expand low-cost commercial use of LEO to US DOD
- Customers exist for Earth observation satellites but there are still questions about long-term, persistent revenue stream

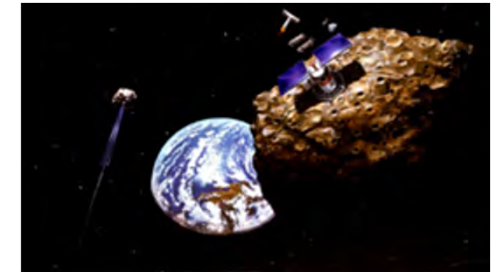


Market sector – Lunar and Deep Space Exploration



Asteroid Mining – two well-known companies did not succeed

- Deep Space Industries – purchased by Bradford Space in Jan 2019
- Planetary Resources – purchased by Consensus in Oct 2018
- Accessing asteroid and returning resources to Earth is too costly
- Technology not mature enough to make validate return on investment



Lunar Exploration

- Google Lunar X Prize – Stopped in 2018 with no winner
- NASA Commercial Lunar Payload Services eligible companies (**bold** have contracts awarded)

- **Astrobotic Technology, Inc.**
- Deep Space Systems
- Draper (partner with iSpace)
- Firefly Aerospace, Inc.
- **Intuitive Machines, LLC**
- Lockheed Martin Space
- **Masten Space Systems, Inc.**

- Moon Express
- Orbit Beyond (partner with Team Indus)
- Blue Origin
- Ceres Robotics
- Sierra Nevada Corporation
- SpaceX
- Tyvak Nano-Satellite Systems, Inc



Market sector – human space flight and tourism



- Virgin Galactic – first launch of customers on sub-orbital tourist flight continues to be delayed
- Axiom – Working closely with NASA on developing commercial space station for astronaut training and tourism flights
- Blue Origin and SpaceX both planning customer spaceflight mission in next several years
- Bigelow – Was building space station capability using inflatables; laid off entire workforce in March 2020
- The press attention and customer demand for commercial human spaceflight is significant
- Accounting for significant risks to human safety leads to delays in development



Market sector – On-orbit servicing



- Debris removal – Many satellites will launch into LEO and GEO and a percentage will fail; these need to be removed
- Refueling – The cost of keeping a satellite refueled and on-orbit is cheaper than launching a new one
- Orbit raising – Some satellites will be inserted in an incorrect or inconvenient orbit
- Life extension – Station keeping of a satellite in GEO to maintain attitude
- Satellite repair – Servicing satellite with robotic arms to fix a customer
- In-situ inspection – No docking; only a fly around inspection to assess the health and neighborhood of a customer



Impact of COVID-19

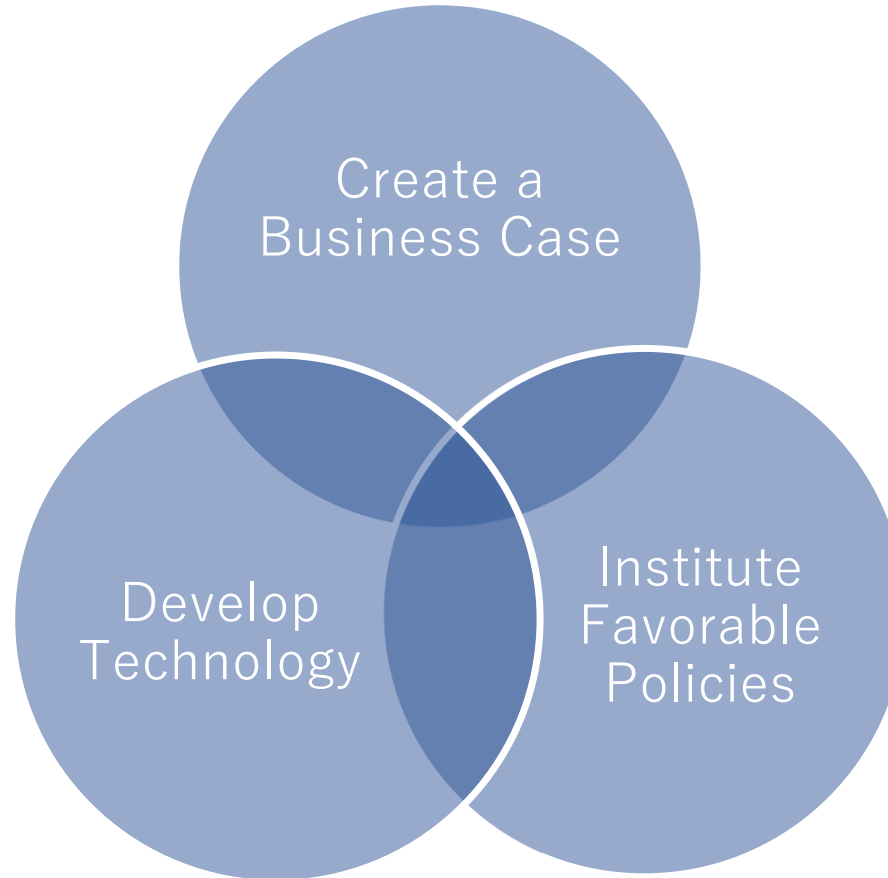
Impact of COVID-19



- January 2020 – just before COVID the level of investment in space ventures was at a peak
- COVID-19 impact on the space sector showed “sharp declines, early signs of recovery, and continued momentum...” (Space Angels, Q2 2020)
- Near term – as with all industries there are effects
 - High profile bankruptcies (eg OneWeb)
 - Launch and satellite production delays
- Long term –robust development will continue
 - 2020-2030: About 10,000 satellites under 500kg still expected to be launched (Euroconsult)
 - Impacts of COVID-19 show the increased need for data from space and will lead to increased investment in certain sectors

Factors for Future Success

What do we need for space economy to succeed



Strong cooperation between government and venture companies is essential



Support start-up community as a customer

- SpaceX would not be where it is today without NASA as a prime customer
- The space market overall still is not mature enough to be supported by commercial customers alone
- Partner on creative funding ideas – public private partnerships; innovative prizes, etc

Prove technical capability and reduce costs

- In all of these market sectors the companies have to prove technical capability e; no one will commit to unproven technology
- R&D investments and joint funding help to progress the technology and make customers feel secure in purchasing services
- Difficult to achieve cost benefits of vertical integration or mass production

Draft policies that are favorable to commercial sector

- There is fine balance between over regulation and no regulation
- US and Japan are both introducing a variety of policy updates that support commercial space

Highlight the benefits of space to the public

- General public is excited by space but still sees it as removed from every day life
- Work together to make the value of space exploration and utilization clear to citizens

What will the future look like in space....?

What will venture space sector look like in the future?



2030

- Internationally-crewed, government-financed human outpost on the Moon
- Several human-tended space stations in orbit (ISS, Gateway, commercial stations, etc)
- On-orbit servicing as a common business
- Launch every week somewhere in the world
- Space Traffic Management is accepted and implemented, including SSA, ADR and OOS

2050

- Multiple lunar outposts, and multiple human-tended space stations both public and private
- Mining and resource extraction on Mars, the Moon and other interplanetary bodies, for science and business
- Vibrant low-Earth orbit environment with thousands of satellites doing science, servicing
- Frequent instances of satellite servicing for debris removal, transit to different orbits, satellite life extension
- Daily flights to low-Earth orbit and even to the Moon for tourism, science, business and government work

**In summary, the environment and economy in space will be similar to that of a town on Earth.
There will be tourism, transportation, law enforcement, manufacturing, etc,**