

**Presentation for EASTASN 402A (EE 402A)  
Stanford University, 16 November 2017**

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# **Current Trends and Future Prospects for Commercial Space Businesses in Asia**

**Richard B. Dasher, Ph.D.  
Director, US-Asia Technology Management Center  
Adjunct Professor, Stanford University**

# Outline



- ◆ **Understanding space industries worldwide**
  - ◆ **Especially satellite industries: satellite services & manufacturing, launch services, ground equipment**
  - ◆ **Changing roles of governments**
  - ◆ **Growth of private sector**
- ◆ **Asia focus**
  - ◆ **Governments**
  - ◆ **Big telcos**
  - ◆ **Startups**
- ◆ **Dynamics of space industries from now**

# The Big Picture: The Space Economy (global markets) (a.k.a. Space Industries Revenues)

	2014 (\$ bn)	y-y growth (%)	2015 (\$ bn)	y-y growth (%)	2016 (\$ bn)
<b>Space industries</b>	<b>322.7</b>	<b>3.9</b>	<b>335.3</b>	<b>1.1</b>	<b>339.1</b>
<b>Non-satellite industry</b>	<b>119.7</b>	<b>6.2</b>	<b>127.0</b>	<b>?? &lt;-38.1&gt;</b>	<b>78.6</b>
<b>Satellite services</b>	<b>122.9</b>	<b>3.7</b>	<b>127.4</b>	<b>0.2</b>	<b>127.7</b>
<b>Satellite manufacturing</b>	<b>15.9</b>	<b>4.4</b>	<b>16.6</b>	<b>&lt;-16.3&gt;</b>	<b>13.9</b>
<b>Launch services</b>	<b>5.9</b>	<b>&lt;-8.5&gt;</b>	<b>5.4</b>	<b>1.9</b>	<b>5.5</b>
<b>Ground Equipment</b>	<b>58.3</b>	<b>1.0</b>	<b>58.9</b>	<b>?? 92.5</b>	<b>113.4</b>

Source: Bryce Space & Tech, annual "State of the Satellite Industry" reports, 2015, 2016, 2017  
– prepared for Satellite Industry Association <<http://www.sia.org/>>

## Notes on the big picture (previous slide)

- ◆ **Size comparison: global semiconductor industry sales \$377.8 bn (forecast for 2017), but = 11.5% increase over 2016**
- ◆ **Space industries: slow growth – but big changes in structure**
  - ◆ **Some sectors growing rather rapidly, some are shrinking**
- ◆ **Unexplained oddity (prev page): sudden drop in non-satellite industry size and sudden jump up in ground equipment size**
  - ◆ **Does not match what the report gives as annual growth rates**
  - ◆ **Change in data classification in 2017 report? (shows 2016 data)**
- ◆ **Biggest sector of the space economy is satellite-related (including services and ground equipment = \$260.5 bn)**
  - ◆ **Non-satellite industry is not defined by the source (SIA report)**
    - ◆ **Contractors for interplanetary, deep space missions?**
    - ◆ **Worldwide space insurance premiums in 2015 = over \$700M, insured losses in 2014 exceeded \$600M**
- ◆ **U.S. portion of this global satellite industry = \$110.3 bn**
  - ◆ **Non-U.S. portion = \$150.2 bn**

# Satellite services growth – global markets

	2012 (\$ bn)	2013 (\$ bn)	2014 (\$ bn)	2015 (\$ bn)	2016 (\$ bn)
<b>Satellite services</b>	<b>113.5</b>	<b>118.6</b>	<b>122.9</b>	<b>127.4</b>	<b>127.7</b>
<b>Consumer</b>	<b>93.3</b>	<b>98.1</b>	<b>100.9</b>	<b>104.3</b>	<b>104.7</b>
• Satellite TV	88.4	92.6	95.0	97.8	97.7
• Satellite Radio	3.4	3.8	4.2	4.6	5.0
• Satellite Broadband	1.5	1.7	1.8	1.9	2.0
<b>Fixed</b>	<b>16.4</b>	<b>16.4</b>	<b>17.1</b>	<b>17.9</b>	<b>17.4</b>
• Transponder agreements	11.8	11.8	12.3	12.4	11.2
• Managed svcs	4.6	4.6	4.8	5.5	6.2
<b>Mobile</b>	<b>2.4</b>	<b>2.6</b>	<b>3.3</b>	<b>3.4</b>	<b>3.6</b>
<b>Earth observation</b>	<b>1.3</b>	<b>1.5</b>	<b>1.6</b>	<b>1.8</b>	<b>2.0</b>

Source: Bryce Space & Tech, annual “State of the Satellite Industry” reports, 2015, 2016, 2017  
– prepared for Satellite Industry Association <<http://www.sia.org/>>

## Notes on satellite services – previous slide

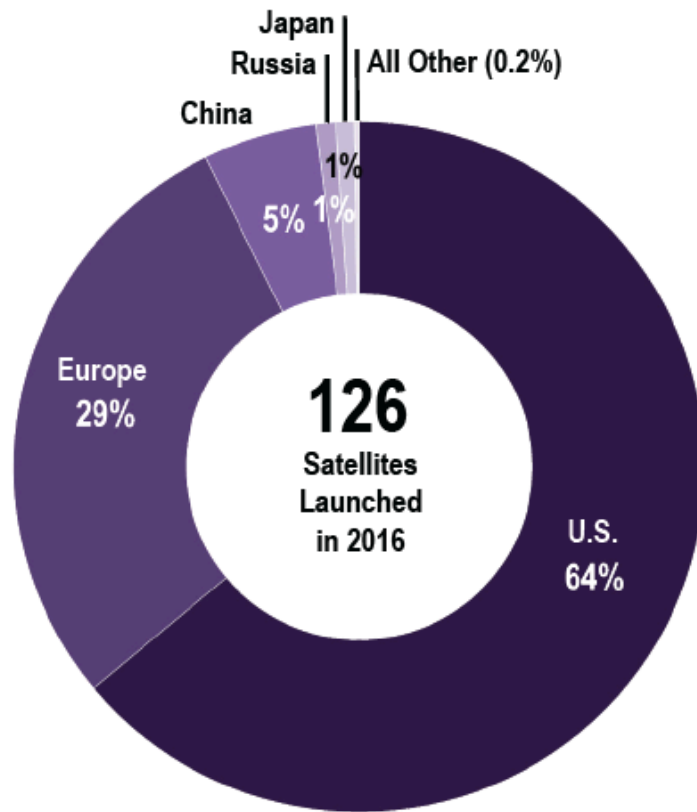
- ◆ Overall slowdown to 0.2% growth between 2015 – 16
  - ◆ Historically had been 4 – 5% growth per year since 2012
  - ◆ U.S. share of global satellite services revenues was 41% in 2016
- ◆ Greatest growth in consumer segments
  - ◆ Satellite TV services: ~ 220M pay-TV subscribers worldwide, plus more with free services
  - ◆ Growth driven by increasing demand in emerging markets, premium services in U.S.
  - ◆ Demand for satellite capacity may slow: compression technologies are improving, growth of IP-based (Internet) video services
- ◆ Managed services growth driven by in-flight Internet
- ◆ Mobile: maritime, airborne, some rail communications (Ku- and Ka- band)
- ◆ Earth observation: small segment but growing – industry expects more growth (51% of satellites launched in 2016 for EO)

# Satellite manufacturing and launch services

	2012 (\$ bn)	2013 (\$ bn)	2014 (\$ bn)	2015 (\$ bn)	2016 (\$ bn)
<b>Satellite manufacturing</b>	<b>14.6</b>	<b>15.7</b>	<b>15.9</b>	<b>16.0</b>	<b>13.9</b>
• <b>U.S.</b>	<b>8.2</b>	<b>10.9</b>	<b>9.9</b>	<b>9.4</b>	<b>8.9</b>
• <b>Non-U.S.</b>	<b>6.4</b>	<b>4.8</b>	<b>6.0</b>	<b>6.6</b>	<b>5.0</b>
<b>Launch services</b>	<b>5.8</b>	<b>5.4</b>	<b>5.9</b>	<b>5.4</b>	<b>5.5</b>
• <b>U.S.</b>	<b>2.0</b>	<b>2.4</b>	<b>2.4</b>	<b>1.8</b>	<b>2.2</b>
• <b>Non-U.S.</b>	<b>3.8</b>	<b>2.9</b>	<b>3.8</b>	<b>3.6</b>	<b>3.3</b>

Source: Bryce Space & Tech, annual “State of the Satellite Industry” reports, 2015, 2016, 2017  
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# Notes on satellite manufacturing

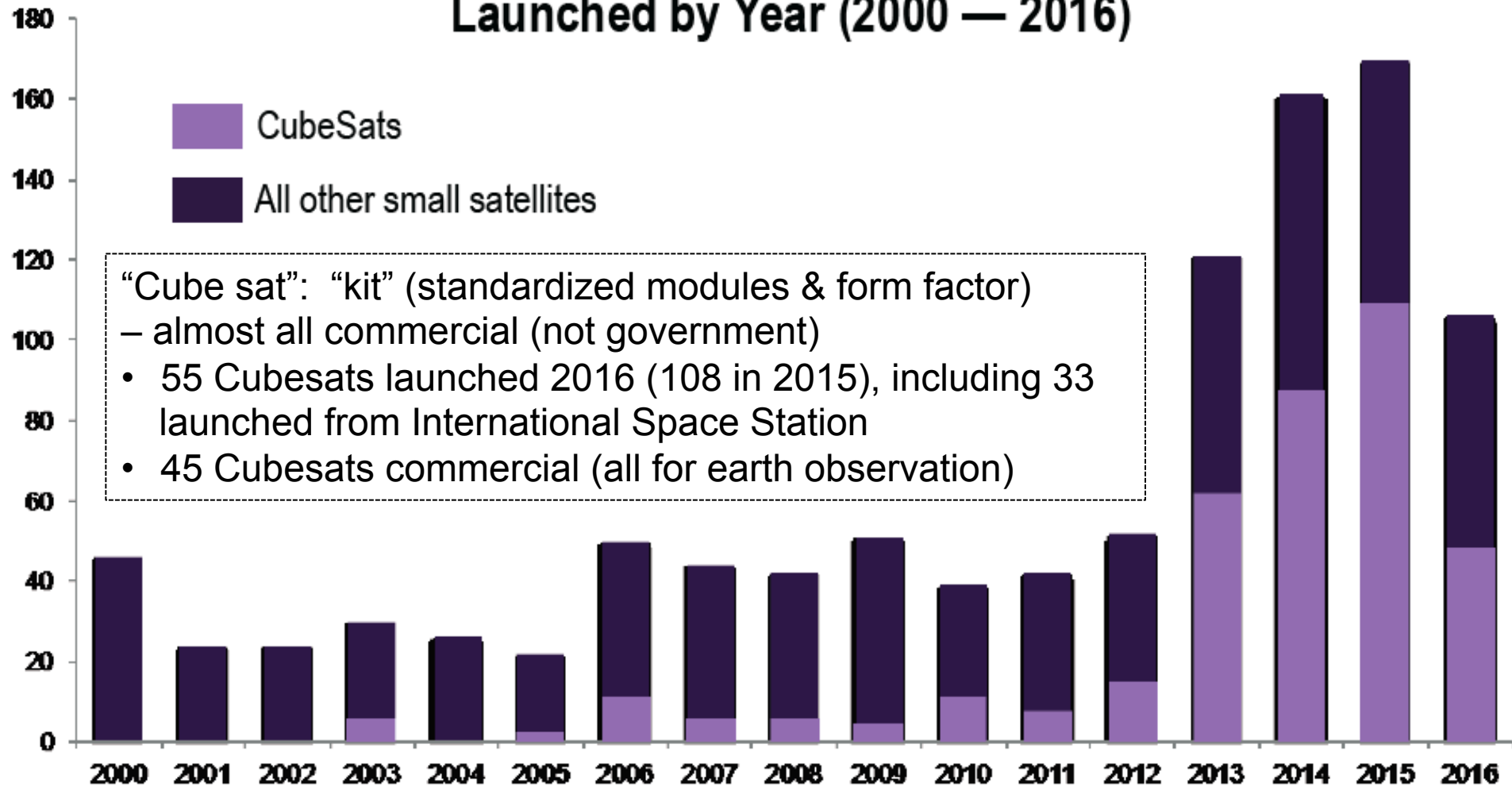


Estimated Value of Spacecraft Launched by Country/Region of Manufacturer (2016)

- Pie chart to left: % = **value of sats**, not number of launches or number of sats
- CRS report: **1,419 sats in operation (2016)** [government and commercial]
  - 576 U.S.
  - 140 Russian
  - 181 Chinese
  - 522 Other nations
- Sats in operation (2016) [CRS Report]
  - 55% LEO
  - 36% GEO
  - 7% MEO
  - < 2% HEO (higher than GEO)
- (Previous page) **drop in manufacturing revenues** (between 2015 – 2016)
  - Fewer satellites than in 2015
  - Relatively more small sats, but total cost of small sats declined



## Number of Very Small Satellites ( $\leq 600$ kg) Launched by Year (2000 — 2016)



Source: Bryce Space & Tech, annual “State of the Satellite Industry” reports, 2015, 2016, 2017  
 – prepared for Satellite Industry Association <<http://www.sia.org/>>

# Notes on launch services industry

- ◆ **Relatively flat revenues since 2012 (around \$5.5 bn)**
  - ◆ **Year-to-year variation in part due to small sample size**
  - ◆ **General trend: number of payloads has increased but offset by cost reductions (more very small satellites)**
- ◆ **2015: 86 launch attempts, 83 successful [CRS Report]**
  - ◆ **Put up 262 spacecraft**
  - ◆ **126 spacecraft of 10 kg or less**
  - ◆ **22 launches were commercial; 64 were government payloads (about 70% of launch revenues from government payers)**
- ◆ **2016 data [SIA Report]**
  - ◆ **U.S. providers: 18 commercial payload launches**
  - ◆ **11 Ariannespace launches (same as in 2015)**
  - ◆ **20 Chinese satellite launches (19 in 2015), but 2016 launches yielded less revenue than in 2015**
  - ◆ **India: 4 launches in 2015 (including 3 PSLV) [ISRO website]**
  - ◆ **2 Russian launches of commercial payloads**
  - ◆ **SpaceX grounding delayed several payloads until 2017**

## Ground equipment (for satellite systems) – highest growth rate of major satellite industry categories

	2012 (\$ bn)	2013 (\$ bn)	2014 (\$ bn)	2015 (\$ bn)	2016 (\$ bn)
<b>Total</b>	<b>75.4</b>	<b>91.2</b>	<b>101.8</b>	<b>106.0</b>	<b>113.4</b>
• <b>Network equipment</b>	<b>9.9</b>	<b>8.8</b>	<b>9.3</b>	<b>9.6</b>	<b>10.3</b>
• <b>Consumer (GNSS satellite navigation)</b>	<b>52.7</b>	<b>66.8</b>	<b>74.6</b>	<b>78.1</b>	<b>84.6</b>
• <b>Consumer (TV, radio bband, mobile non-GNSS)</b>	<b>12.8</b>	<b>15.6</b>	<b>17.9</b>	<b>18.3</b>	<b>18.5</b>

Source: Bryce Space & Tech, annual “State of the Satellite Industry” reports, 2015, 2016, 2017  
– prepared for Satellite Industry Association <<http://www.sia.org/>>

# Notes on ground equipment

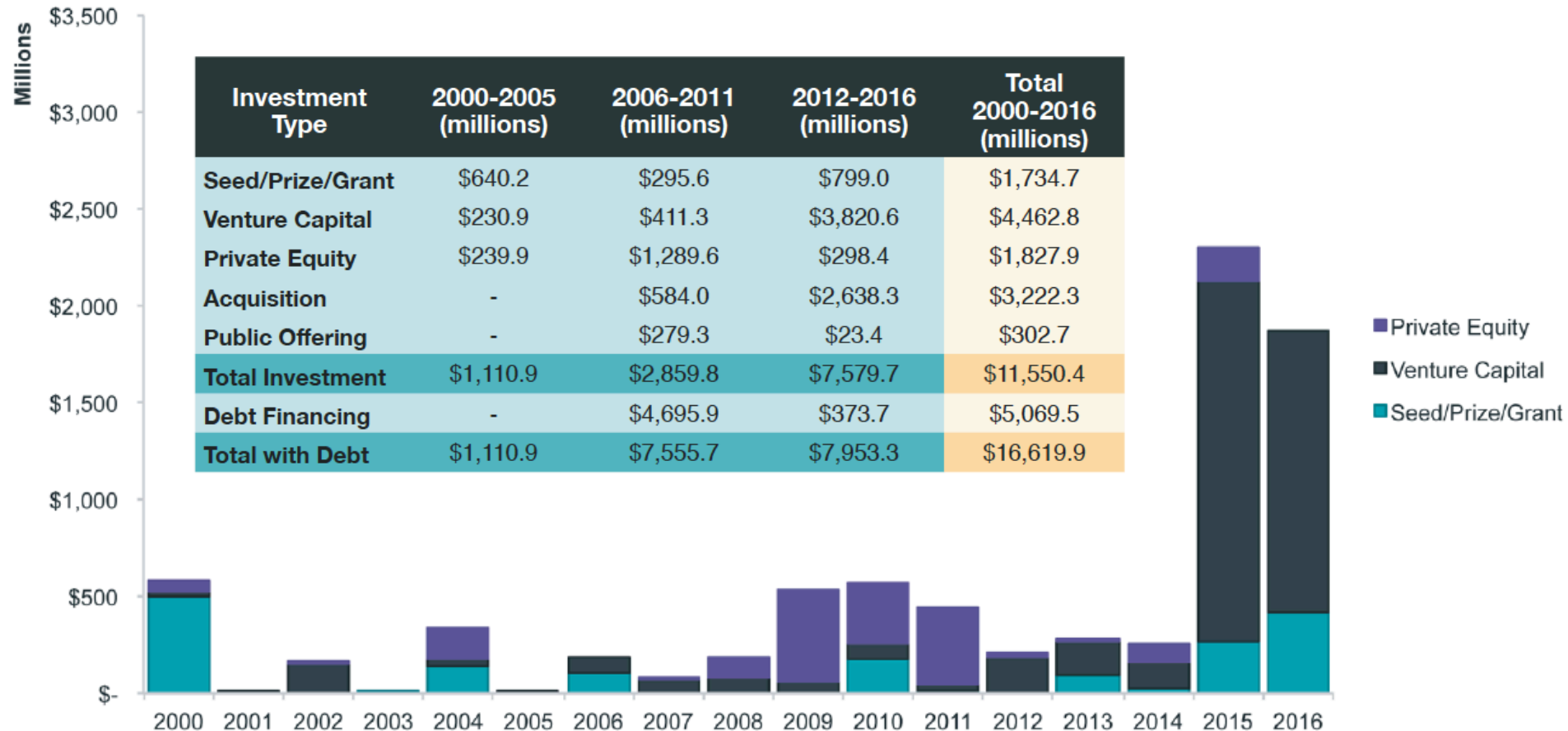


- ◆ **As with satellite services, greatest growth in consumer equipment spaces (8% in 2016 over 2015 but recent slowdown of satellite TV growth)**
  - ◆ **Especially GNSS (Global Navigation Satellite Systems)**
  - ◆ **GNSS includes stand-alone and in-auto units ( ~ \$32 bn / year) and GPS chipsets in mobile devices, avionics, maritime, surveying, rail**
- ◆ **Network equipment revenues grew 7% (2016 over 2015)**
  - ◆ **Driven by growth in “managed services,” including in-flight connectivity**
- ◆ **Consumer equipment for satellite TV etc. only 1% growth (2016 over 2015)**
  - ◆ **Satellite TV receivers flat (negative growth in some markets)**

# Changing roles of governments in space industries

- ◆ **Government customers still account for about 70% of space industry revenues**
- ◆ **Refer to October 5, 2017, presentation in this series**
- ◆ **Change in government contracts, especially in U.S.**
  - ◆ **Earlier: “cost-plus” contracts – government determined detailed requirements, contractors were paid for projected costs plus a pre-determined profit (% of actual costs)**
  - ◆ **More recent: “fixed price” – competitive bids for some product or service (less internal control over contractor budget)**
    - ◆ **Encourages more commercial mindset by contractors, increases competition possibilities**
- ◆ **Regulations still an issue**
  - ◆ **Export controls restricting U.S. companies**
  - ◆ **Spectrum allocations: some satellite frequencies may be given over to 5G wireless communications (ground-based)**

# Private sector investments show growth of commercial space industry, especially startups



Bryce Space and Technology, 2017, "Start-up Space: Investment in Commercial Space Ventures – 2017, [https://brycetek.com/downloads/Bryce\\_Start\\_Up\\_Space\\_2017.pdf](https://brycetek.com/downloads/Bryce_Start_Up_Space_2017.pdf)

# Notes on private sector investment in space

- ◆ Refer to October 5, 2017, session in this series: impact of Elon Musk, Jeff Bezos, and other very wealthy persons
- ◆ Sudden big jump up in venture capital investments in 2015 and 2016 from earlier levels
  - ◆ But, largely due to a few giant deals
    - ◆ Google invested \$1 billion in SpaceX in 2015
    - ◆ Softbank led a \$1.2 billion investment in OneWeb in 2016
  - ◆ A few other \$90M+ deals
  - ◆ Otherwise, VC investing = about \$260M each year in 2015, 2016 (still much higher than historical levels)
- ◆ Number of VC firms investing in space ventures (110 cumul.)
  - ◆ 89 VC firms in 2015
  - ◆ 62 VC firms in 2016, including 43 not previously in space
- ◆ Of 250 total institutions that have invested, 66% are U.S.; non-U.S. investing institutions are from 25 countries



# **Focus on Asia Commercial Space Ventures**



# Asia governments: have actively adopted satellites for telecom, GNSS, EO

## ◆ Telecom satellites (GEO)

- ◆ Laos (LaoSat-1, 2015)
- ◆ Myanmar (SES 12, 2017)
- ◆ Bangladesh (Bangabandhu-1, sched. 2018)
- ◆ Driven by mobile broadband infrastructure development

## ◆ EO satellites

- ◆ Taiwan (Formosat-5, first domestically developed sat), launched 8/2017 (after delay due to SpaceX pre-launch failure)
- ◆ Philippines (PHL Microsat-1, first domestically developed microsat), launched to ISS via JAXA 3/2016, deployed in 4/2016
  - ◆ First of 50 EO microsattellites in program led by Hokkaido Univ and Tohoku Univ (Japan) in partnership with Bangladesh, Indonesia, Malaysia, Myanmar, Mongolia, Philippines, Thailand, and Vietnam

## ◆ GNSS

- ◆ India: IRNSS (NAVIC) constellation of 7 sats with 2 backup – in orbit but in final testing

## Some private satellite operators in Asia

- ◆ **Kacific (High-speed internet for Indonesia, NZ, etc.)**
- ◆ **Bank Rayat Indonesia (BRIsat): GEO, for banking by satellite**
- ◆ **Thaicom PLC (fleet of communications sats)**
- ◆ **MEASAT (Malaysian communication sat provider) – operates MEASAT and AFRICASAT**
- ◆ **KT SAT (subsidiary of Korea Telecom) – six GEO launches since 1970**
- ◆ **APT Satellite Holdings (Hong Kong) operates Apstar constellation**
- ◆ **Sky Perfect JSAT Corp. (Japan) – multichannel pay TV broadcasting and satellite communications in Japan & region**
- ◆ **Singapore**
  - ◆ **Multiple operators: SES World Skies, Telesat Network Svcs, +4**
  - ◆ **TeLEOS-1 EO sat (1 meter resolution imaging from LEO)**

## A reminder: companies we are featuring in the current series of Stanford seminars

<b>Date</b>	<b>Company</b>	<b>Country</b>	<b>Notes</b>
10/05	<b>SpaceBase</b>	New Zealand	Incubator; speaker sponsored by NZ government fellowship
10/12	<b>Ispace</b>	Japan	HAKUTO rover for Google Lunar XPRIZE
10/19	<b>Axelspace</b>	Japan	EO satellite constellation, emerging focus on data analytics
10/26	<b>Earth2Orbit</b>	India	Launch services, satellite systems, emerging data services
11/09	<b>Fleet Space Technologies</b>	Australia	Communications system from satellite constellation for IOT
11/30	<b>Astroscale</b>	Singapore (Japan)	Space debris tracking, ultimately removal
12/07	<b>Interstellar</b>	Japan	Time sharing for ground stations

## Some other Asia companies we wanted to feature in this series (in no particular order) – Page 1

Company	Country	URL	Notes
KuangChi Space Technology	China (Hong Kong)	<a href="http://www.kuang-chi.com/en/">http://www.kuang-chi.com/en/</a>	Strategic investments in space-related ventures
Starburst Accelerator	Office in Singapore	<a href="http://starburst.aero/">http://starburst.aero/</a>	SG partnership with Leonie Capital – SG\$200M fund
PD Aerospace	Japan	<a href="http://pdas.co.jp/">http://pdas.co.jp/</a>	Hybrid jet / rocket engine aims for suborbit tourism
Gilmour Space	Austral / SG	<a href="https://www.gspacetech.com/">https://www.gspacetech.com/</a>	Hybrid engine for low cost launch services
OneSpace	China	<a href="http://www.onespacechina.com/">http://www.onespacechina.com/</a>	Chinese version of SpaceX
Space Shift	Japan	<a href="http://www.spcsft.com/en">http://www.spcsft.com/en</a>	Microsat manufacturing and kits

## Some other Asia companies we wanted to feature in this series (in no particular order) – Page 2



Company	Country	URL	Notes
ALE Co., Ltd.	Japan	<a href="http://star-ale.com/en/">http://star-ale.com/en/</a>	Artificial meteor showers for entertainment



# **Prospects for commercial space businesses from now**

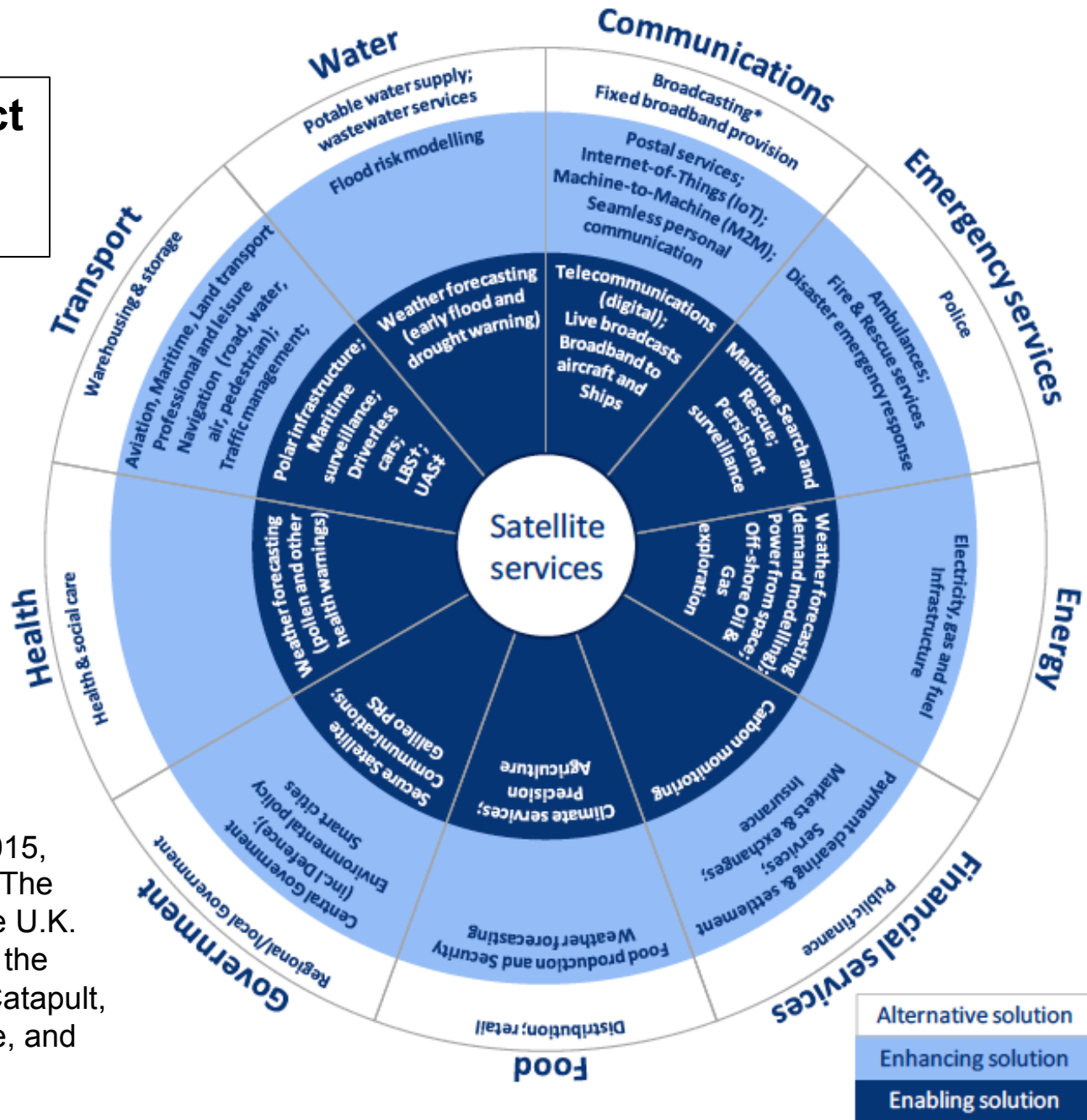
**With special attention to Asia**

# Space industries commercial applications areas



<b>Established or under active development</b>	<b>Still early in development or in future</b>
Weather forecasting	Agricultural management
Telecom	Other environment management
Media content providing	Driverless vehicle management
Navigation, supply chain mgmt	Tourism, transport
(Security services)	Power delivered from space
Insurance (e.g. climate risk mgmt)	Manufacturing in space
	Mining of celestial bodies

# Broader impact of satellite services



London Economics, 2015, "The Case for Space: The Impact of Space on the U.K. Economy." A study for the Satellite Applications Catapult, Innovate UK, UKSpace, and UK Space Agency



# Asia drivers of space businesses from now



- ◆ **Economic development has preceded infrastructure development – satellites may help leapfrog development of new services without traditional ground based infrastructure**
  - ◆ **Large regions that need to be integrated into the Internet cloud (China interior, Mongolia, SE Asia, India rural areas, ... )**
  - ◆ **China & other large Asia countries may be motivated to adopt space-enabled (leapfrog) technologies for less-developed regions In order to narrow rich-poor income gap (GINI index),**
- ◆ **National pride: expect less reliance on U.S. and Europe service providers in future**
  - ◆ **Government education programs (just about everywhere): promote STEM via space, some strong university research groups**
- ◆ **University research in Asia – now a lot of focus on innovation (commercialization)**

# Summary and final comments

- ◆ **Commercial space industries combine some well-established application areas with a lot of “moon shot” ideas**
  - ◆ **Will continue to be an area for enabling technologies across multiple industry verticals**
  - ◆ **Shift in government role: from contracting agency for national programs to customer**
    - ◆ **Governments will continue to be important customer and provide important early stage subsidies (grants) at least for next generation**
- ◆ **Space is robust area for startup creation, although absolute number of companies not so large**
  - ◆ **Wealthy angels, recent major jump up in VC funding**
- ◆ **Asia is a part of the recent take-off of space-related startups**
  - ◆ **Easy for U.S. not to pay attention**
  - ◆ **Expect to see continuing stream of interesting innovations from Asia**