Smallsats by the Numbers
2020
Overview

- Introduction
- 2019 Smallsat Highlights
- Commercial Smallsats
- Government Smallsats
- Non-Profit and Academic Smallsats
- Looking Forward: Areas To Watch
Introduction

- Smaller satellites are of increasing interest; more widely used in recent years
- Bryce’s *Smallsats by the Numbers* presents historical information on smaller satellites launched 2012-2019 (regardless of operational status)
- Definition used here, 600 kg and under, reflects the five smallest mass classes defined by the FAA
- ‘Smallsat’ or ‘very small satellite’ are often used to refer to smaller satellites

<table>
<thead>
<tr>
<th>Mass Class Name</th>
<th>Kilograms (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femto</td>
<td>0.01 – 0.09</td>
</tr>
<tr>
<td>Pico</td>
<td>0.1 – 1</td>
</tr>
<tr>
<td>Nano</td>
<td>1.1 – 10</td>
</tr>
<tr>
<td>Micro</td>
<td>11 – 200</td>
</tr>
<tr>
<td>Mini</td>
<td>201 – 600</td>
</tr>
<tr>
<td>Small</td>
<td>601 – 1,200</td>
</tr>
<tr>
<td>Medium</td>
<td>1,201 – 2,500</td>
</tr>
<tr>
<td>Intermediate</td>
<td>2,501 – 4,200</td>
</tr>
<tr>
<td>Large</td>
<td>4,201 – 5,400</td>
</tr>
<tr>
<td>Heavy</td>
<td>5,401 – 7,000</td>
</tr>
<tr>
<td>Extra Heavy</td>
<td>&gt; 7,001</td>
</tr>
</tbody>
</table>

From FAA *The Annual Compendium of Commercial Space Transportation: 2018*
### 2019 Smallsat Highlights

- **389 Smallsats Launched**
- **37%** Communications
- **32%** Technology Development
- **26%** Remote Sensing
- **3%** Scientific
- **2%** Other/Unknown

**Average Smallsat Mass**

- **109 kg**
- Nearly 2x increase from 2018, 6x increase from 2017

**Launches by Use**

- **45%** of launches included smallsats, nearly doubling from 24% in 2012
- **28%** dedicated smallsat launches, almost half by China
- **57%** of smallsats launched by U.S. launch providers

Highlights

1,700+ smallsats launched

52% of smallsats provide commercial services

11x increase in proportion of upmass represented by smallsats over 7 years

Smallsat usage began to increase in 2012

Government and commercial sectors are increasingly using smallsats
The Big Picture of Smallsats: Smallsats in Context


Number of Spacecraft Launched

<table>
<thead>
<tr>
<th>Year</th>
<th>Smallsat (0.01-600 kg)</th>
<th>Small (601-1,200 kg)</th>
<th>Intermediate (2,501-4,200 kg)</th>
<th>Medium (1,201-2,500 kg)</th>
<th>Heavy (5,401-7000 kg)</th>
<th>Extra Heavy (7,000+ kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>52</td>
<td></td>
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</tr>
<tr>
<td>2013</td>
<td>130</td>
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<tr>
<td>2014</td>
<td>195</td>
<td></td>
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<tr>
<td>2015</td>
<td>173</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>126</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>338</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>328</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>389</td>
<td></td>
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</tr>
</tbody>
</table>
Number of Smallsats by Mass Class
Share of SmallSats by Mass Class

SmallSat Trends (2012 – 2019)
Share of Smallsats by Use

Planet owned 55% of remote sensing smallsats launched; SpaceX owned nearly 50% of communications smallsats.
Number of Smallsats by Operator Type


Share of smallsats providing commercial services grew from 6% in 2012 to 62% in 2019
Average Smallsat Mass
### Smallsats as Percentage of Total Upmass


<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>% of Total Upmass Represented by Smallsats</td>
<td>1%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>5%</td>
<td>11%</td>
</tr>
</tbody>
</table>

*In 2019, smallsats made up 11% of all mass launched into orbit*
Percentage of Smallsats by Operating Country

1,731 Smallsats Launched (2012 – 2019)

- USA: 60%
- China: 10%
- Russia: 4%
- Japan: 4%
- Germany: 3%
- Each 1%: Austria, Canada, India, South Korea, UK
- 57 countries and Europe: 14%
Percentage and Number of Smallsats by Country of Launch Provider

Rocket Lab is headquartered in the U.S. with a subsidiary in New Zealand. It is counted here as a U.S. company.
Percentage of Launches With Smallsats
Share of Smallsats by Launch Vehicle Category


63% 37%
95% 5%
74% 26%
84% 16%
92% 8%
87% 13%
80% 20%

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

*FAA definitions of medium-heavy and small launch vehicles

Medium-Heavy Launch Vehicles (Capacity >2,268 kg)*
Small Launch Vehicles (Capacity ≤2,268 kg)*

Bryce Space and Technology
Launches Dedicated to Smallsats
Percentage of Smallsats Launched that are CubeSats

CubeSats are a “kit” form of smallsat with a standard form factor

- 1 kg, 10-centimeter cube = 1 unit = 1U
- Can combine to form larger CubeSats (e.g. 3U, 6U, more)

1,126 CubeSats Launched (2012 – 2019)
Number of CubeSats Launched Directly into Orbit vs Deployed From ISS
Commercial Smallsats

Highlights

- **899**: commercial smallsats launched, 2012 – 2019
- **68%**: for remote sensing
- **81%**: manufactured by U.S. companies
- **70%**: owned by Planet, SpaceX, Spire (largest smallsat operators)
Commercial Smallsats by Use

Commercial Smallsats

- Remote Sensing
- Technology Development
- Communications
- Scientific
- Other/Unknown

Percentage of Commercial Smallsats Launched

- 2012: 33%
- 2013: 21%
- 2014: 87%
- 2015: 76%
- 2016: 97%
- 2017: 93%
- 2018: 61%
- 2019: 58%

Number of Commercial Smallsats

- 2012: 67
- 2013: 57
- 2014: 86
- 2015: 92
- 2016: 97
- 2017: 122
- 2018: 148
- 2019: 227

Other/Unknown Commercial Smallsats Launched in 2019:

- Number of Smallsats Launched:
  - Remote Sensing: 140
  - Technology Development: 22
  - Communications: 80
  - Scientific: 22
  - Other/Unknown: 1
Percentage by Operator
Commercial Smallsats

- **113 Commercial Operators**
  - 30%
  - 43% (Planet)
  - 13% (Spire)
  - 14% (SpaceX)

899 Commercial Smallsats Launched (2012 – 2019)
Government Smallsats

Highlights

353

government smallsats launched 2012 – 2019

38%

owned by U.S. government (about 1/3 NASA)

42

governments (including Europe) own smallsats
Total Number of Government Smallsats (2012 – 2019)

Government Smallsats

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Government Smallsats</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>140</td>
</tr>
<tr>
<td>China</td>
<td>50</td>
</tr>
<tr>
<td>Russia</td>
<td>40</td>
</tr>
<tr>
<td>Japan</td>
<td>20</td>
</tr>
<tr>
<td>India</td>
<td>10</td>
</tr>
<tr>
<td>Germany</td>
<td>5</td>
</tr>
<tr>
<td>Europe</td>
<td>3</td>
</tr>
<tr>
<td>Taiwan</td>
<td>3</td>
</tr>
<tr>
<td>Italy</td>
<td>3</td>
</tr>
<tr>
<td>Sweden</td>
<td>3</td>
</tr>
<tr>
<td>Japan</td>
<td>2</td>
</tr>
</tbody>
</table>

Six or Fewer Government Smallsats

- Iran
- Vietnam
- Canada
- Egypt
- South Korea
- Ecuador
- Norway
- Singapore
- France
- Belarus
- Australia
- Argentina
- Algeria
- Philippines
- North Korea
- Ethiopia
- Israel
- Colombia
- United Kingdom
- Malaysia
- Poland
- Kazakhstan
- Brazil
- Spain
- Turkey
- Mexico
- Saudi Arabia
- Pakistan
- UAE
- Peru
- Indonesia
- Rwanda
- Italy
- Sweden
## Largest Government Smallsat Operators

### Government Smallsats

<table>
<thead>
<tr>
<th>Type</th>
<th>Operator</th>
<th># of Satellites Launched 2012 – 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil</td>
<td>National Aeronautics and Space Administration (NASA)</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Russian Federal Space Agency (Roscosmos)</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Los Alamos National Laboratory (LANL), US</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Japan Aerospace Exploration Agency (JAXA)</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Indian Space Research Organisation (ISRO)</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>European Space Agency (ESA)</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>National Space Program Office (NSPO), Taiwan</td>
<td>7</td>
</tr>
<tr>
<td>Military (based on public sources)</td>
<td>US DoD</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Russia Ministry of Defence</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>People's Liberation Army (PLA), China</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Project Biarri, Australia</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Korean People's Army</td>
<td>3</td>
</tr>
</tbody>
</table>
Academic and Non-Profit Smallsats

Highlights

459 smallsats launched by academic (348) and non-profit (111) organizations 2012 – 2019

~80% for technology development

242 academic (189) and non-profit (53) organizations own smallsats (often only one or two)
Number of Academic Smallsats by Institution

Academic and Non-Profit Smallsats

Nearly 190 academic operators launched smallsats 2012 – 2019

- Kyushu Institute of Technology
- Technical University of Berlin
- University of Colorado at Boulder
- California Polytechnic State University
- Nanyang Technical University
- San Jose State University
- Tsinghua University
- University of Toronto
Business Outcomes
Smallsat business ventures of all types continue efforts to prove both their business models and their ability to generate significant revenue. Financial outcomes of today’s smallsat companies will impact the long-term smallsat market.

Communications Constellations
Smallsat telecommunications operators have said they plan to launch tens of thousands of smallsats. Initial deployment of these large constellations will dominate smallsat activity in the next few years.

Small Launch Vehicles
Dozens of new small launch vehicles (many <500kg capacity) are in development to launch smallsats. Governments are increasingly interested in small launch vehicles. Among commercial customers, competition from larger vehicles and uncertainty in smallsat business cases will shape the market.

Orbital Debris
Large smallsat constellations raise concerns about orbital debris. How businesses and policy makers respond to debris risk will be a trend to watch in 2020.
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