Smallsats by the Numbers 2019
Overview

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- Commercial Smallsats
- Government Smallsats
- Non-Profit and Academic Smallsats
- CubeSats
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Introduction

What Are Smallsats?

- Although definitions vary, **600 kg and under** reflects the five smallest mass classes defined by the FAA

- ‘Smallsat’ or ‘very small satellite’ often used to refer to smaller satellites

- CubeSats are an established “kit” form of smallsat
  - Use standard 10 cm³ form factor (1U), ~ 1 kg
  - Can combine to form 3U, 6U, 12U, or more

- Smaller satellites are of increasing interest; more widely used in recent years

<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>10.1 - 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>

Smallsat Applications

Common Uses

- Remote Sensing
- Technology Development
- Military and Intelligence
- Communications
- Science
Recent Events and Trends
2012 - 2018

- In 2012, smallsats began to see significantly increased usage
- Over **1,300** smallsats launched 2012 - 2018 (includes smallsats on both successful and failed launch attempts)
- 2018 saw **6x** as many smallsats launched as 2012
- Over **70%** of smallsats launched 2012 - 2018 were CubeSats
- **Half** of smallsats launched 2012 - 2018 provide commercial services
- Government and commercial sectors are capitalizing on heightened interest in smallsats
- Launch vehicle failures have affected the rate of smallsat deployment
- CubeSats have dominated the smallsat market; 961 launched 2012 - 2018
Recent Events and Trends

2018 Activity Highlights

55 kg
Average smallsat mass at launch

43%
Of launches involved smallsats

71
Organizations manufacturing smallsats for first time

42
Smallsats successfully launched to be deployed from ISS

36%
Of smallsats were launched from US
Recent Events and Trends

2018 Activity by Application

- **Communications**: 319 (37%)
- **Technology Development**: 8 (2%)
- **Military and Intelligence**: 10 (3%)
- **Remote Sensing**: 35 (11%)
- **Scientific**: 133 (41%)
- **Other/Unknown**: 21 (6%)

Total Smallsats Launched: 319
The Big Picture of Smallsats

Smallsats and All Satellites Launched, 2012 - 2018
The Big Picture of SmallSats

Impact of Launch Failures, 2012 - 2018

2014 Antares launch failure
29 smallsats lost

2016 Falcon 9 pad accident
SmallSat launches delayed into 2017

2017 Soyuz 2.1b launch failure
18 smallsats lost

2015 Super Strypi, Falcon 9 launch failures
21 smallsats lost

2018 Success
only 1 smallsat lost at launch
The Big Picture of Smallsats

Smallsats by Application, 2012 - 2018

Planet deployed 60% of all remote sensing smallsats 2012 - 2018
The Big Picture of SmallSats

SmallSats by Operator Type, 2012 - 2018

![Bar chart showing the number of smallsats launched by operator type from 2012 to 2018. The chart includes categories for Commercial, Government Civil, Government Military, Academic, and Non Profit. Each year shows a significant increase in the total number of smallsats launched.](chart.png)
Commercial SmallSats

2012 - 2018

- In the last seven years, 663 commercial smallsats launched
- Over 80% were for remote sensing
- Over half were manufactured by Planet
- Over 80% were manufactured by US companies
- Planet and Spire account for about two-thirds
- From 2016 to 2018, the total number of commercial smallsats launched increased by 2.5x
Commercial Smallsats

By Application

- Communications: 532 (80%)
- Technology Development: 71 (11%)
- Remote Sensing: 53 (8%)
- Scientific: 5 (1%)
- Other/Unknown: 2 (0%)

663 Commercial Smallsats Launched 2012 - 2018
Of the 90+ commercial operators deploying smallsats 2012 – 2018, these are the top 10.

Notes: Planet has operated Terra Bella satellites since acquiring Terra Bella in 2017. Unlike the rest of the companies shown, ORBCOMM is a long-established operator, that first deployed satellites in the 1990s. In January 2018, Swarm Technologies launched 4 SpaceBee smallsats without authorization from the FCC.
Government Smallsats

Countries Deploying the Most Government Smallsats, 2012 - 2018

<table>
<thead>
<tr>
<th>Countries Deploying the Most Government Smallsats</th>
<th>Smallsats Launched</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>120</td>
</tr>
<tr>
<td>China</td>
<td>44</td>
</tr>
<tr>
<td>Russia</td>
<td>43</td>
</tr>
<tr>
<td>Japan</td>
<td>11</td>
</tr>
<tr>
<td>India</td>
<td>7</td>
</tr>
<tr>
<td>Germany</td>
<td>6</td>
</tr>
</tbody>
</table>

5 or Fewer Government Smallsats Deployed

- South Korea
- Ecuador
- Australia
- Indonesia
- European Space Agency
- Spain
- Canada
- Kazakhstan
- Israel
- Turkey
- Iran
- Peru
- Brazil
- Greece
- Algeria
- Taiwan
- North Korea
- Vietnam
- Saudi Arabia
- Belarus
- UAE
- Pakistan
- Italy
- Philippines
- France
- Colombia
- Poland
- Malaysia
- United Kingdom

Note: Based on public information
## Government SmallSats

### Largest Government SmallSat Operators, 2012 - 2018

<table>
<thead>
<tr>
<th>Type</th>
<th>Operator</th>
<th>Smallsats Launched</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Civil</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NASA, USA</td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>Roscosmos, Russia</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>Los Alamos National Laboratory, USA</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Smolsat/Gonets, Russia</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>China Aerospace Science and Technology Corporation (CASC)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>China National Space Administration (CNSA)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td><strong>Military (based on public sources)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA DoD</td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>Russian MoD</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>People’s Liberation Army (PLA), China</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>Project Biarri (Australia Defence)</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Korean People’s Army</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>
Academic and Non-Profit SmallSats

2012 - 2018

- Academic and non-profit organizations deployed 371 smallsats 2012 - 2018
  - Over 300 were for technology development
  - Over 80% were CubeSats

- Number of academic and non-profit organizations that manufacture smallsats nearly quadrupled from 2012 - 2018

- Over the last six years, nearly 200 non-profit and academic organizations launched smallsats, many deploying only one or two
Academic and Non-Profit SmallSats

Top Academic SmallSat Operators, 2012 - 2018

Over 160 unique academic operators launched smallsats 2012 – 2018

SmallSats Launched

- Kyushu Institute of Technology
- Technical University of Berlin
- University of Colorado at Boulder
- Tsinghua University (Beijing)
- San Jose State University (SJSU)
- Cal Poly Aerospace Engineering
- Nanyang Technical University
- University of Toronto
- University of Surrey
- University of Tokyo ISSL
- Morehead State University
CubeSats

Overview, 2012 - 2018

- In total, **950+** CubeSats launched 2012 - 2018
- About **60%** have provided commercial services; about two-thirds were Planet’s Dove CubeSats
- Over **10%** were government; about **two-thirds** were for civil purposes
- About **25%** were launched by academic organizations
- CubeSats launched per year grew from **23** in 2012 to **230** in 2018
In addition to the successful deployments in this chart, a total of 64 CubeSats were lost in launch failures in 2014, 2015, and 2017. No launch failures affected CubeSats in other years listed.
Outlook

What Lies Ahead for Smallsats

- Smallsat business ventures seek to prove their business models and generate significant revenue in the next few years
- Deployment of future generations of smallsats will often depend on this success
- Dozens of new small launchers in development target smallsats
  - Virgin Orbit, Rocket Lab, and Vector have announced contracts
  - Rocket Lab began commercial operations in 2018; Virgin Orbit and Rocket Lab are conducting test flights with commercial operations expected in 2019
  - High business risks: uncertainty about future smallsat deployment, competition from larger vehicles
- Large smallsat constellations raise concerns about orbital debris: SpaceX, Boeing, and others are developing constellations with 600 to 1,000+ satellites