Overview of the Planet Labs Constellation of Earth Imaging Satellites

In Space to Help Life on Earth

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Technology

The rise of the nanosat

- Small and easier to design, build & test (esp. in large quantity)
- Standardized launch interface, lots of launch opportunity
- Advances in commercial electronics
Opportunity

Earth Imaging trending toward higher resolution

- Expensive, highly sophisticated satellites
- Point & shoot operations
- Limited customer base
The Mission

Technology meets Opportunity

- Launch and operate a large fleet of nanosats
- Image the entire Earth, every day and democratize access
- Use space to help life on Earth
From the Garage
The Dove Satellite
Dove Characteristics

Tech Specs

- 3U cubesat, 5 kg
- 90 mm aperture optical payload
- RGB imaging with commercial-grade CCD, 3 – 5 meter GSD
- Fold-out solar arrays and antenna flap
- Magnetorquers, reaction wheels, star camera, GPS
- 3 year operational lifetime (predicted)
## Dove Frequencies

<table>
<thead>
<tr>
<th>Function</th>
<th>Common Name</th>
<th>Frequency Band</th>
<th>Center Frequencies</th>
<th>Bandwidth</th>
<th>Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Speed Downlink</td>
<td>“X-band”</td>
<td>8025-8400 MHz, space-to-Earth</td>
<td>Ch1: 8133 MHz Ch2: 8200 MHz</td>
<td>66.8 MHz (each channel)</td>
<td>EESS, US258</td>
</tr>
<tr>
<td>High Speed Uplink</td>
<td>“S-band”</td>
<td>2025-2110 MHz, Earth-to-space</td>
<td>2056 MHz</td>
<td>1.31 MHz</td>
<td>EESS, US347</td>
</tr>
<tr>
<td>Backup TT&amp;C Downlink</td>
<td>“UHF”</td>
<td>401-402 MHz, space-to-Earth</td>
<td>401.3 MHz</td>
<td>60 kHz</td>
<td>Space Operation</td>
</tr>
<tr>
<td>Backup TT&amp;C Uplink</td>
<td>“UHF”</td>
<td>449.75-450.25 MHz, Earth-to-space</td>
<td>450.0 MHz</td>
<td>60 kHz</td>
<td>Space Operation, US87, 5.286</td>
</tr>
</tbody>
</table>
Agile Aerospace

A Silicon Valley approach to satellite design

- Capabilities driven
- Launch early, launch often
- Testing over simulation
- 12 full satellite iterations over 3 years
A Flock of Doves

Image the entire Earth, every day

- Need 150 satellites in a single SSO Orbit
- Each satellite takes a picture 1 x sec
- Acts as a line scanner for the Earth
<table>
<thead>
<tr>
<th>Mission</th>
<th>Launch Date</th>
<th>Launch Vehicle</th>
<th># of sats</th>
<th>Orbit</th>
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</thead>
<tbody>
<tr>
<td>Dove 2</td>
<td>4/19/2013</td>
<td>Soyuz</td>
<td>1</td>
<td>575 km, 65 deg</td>
</tr>
<tr>
<td>Dove 1</td>
<td>4/21/2013</td>
<td>Antares</td>
<td>1</td>
<td>300 km, 52 deg</td>
</tr>
<tr>
<td>Dove 3 &amp; Dove 4</td>
<td>11/21/2013</td>
<td>Dnepr</td>
<td>2</td>
<td>700 km, SSO</td>
</tr>
<tr>
<td>Flock 1 (USASAT-30F)</td>
<td>1/9/2014</td>
<td>Antares</td>
<td>28</td>
<td>400 km, 52 deg</td>
</tr>
<tr>
<td>Flock 1c (USASAT-30F)</td>
<td>6/18/2014</td>
<td>Dnepr</td>
<td>11</td>
<td>620 km, SSO</td>
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<tr>
<td>Flock 1b (USASAT-30F)</td>
<td>7/13/2014</td>
<td>Antares</td>
<td>28</td>
<td>400 km, 52 deg</td>
</tr>
<tr>
<td>Flock 1d (USASAT-30F)</td>
<td>10/28/2014</td>
<td>Antares</td>
<td>26</td>
<td>400 km, 52 deg</td>
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<tr>
<td>Flock 1d’ (USASAT-30F)</td>
<td>1/10/2015</td>
<td>Falcon 9</td>
<td>2</td>
<td>400 km, 52 deg</td>
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<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>99</td>
</tr>
</tbody>
</table>
Ground Stations

Getting the data down

- Highly automated
- Locations in the US, UK, New Zealand, Germany and Australia
- Multiple antennas per site
- 5 m parabolic X/S-band (7 m radome)
- Circularly polarized UHF Yagi
Orbital Debris

 Orbit lifetime for Planet Labs' launches as of Oct 2014

Ballistic coefficient, $BC = 45 \text{ kg/m}^2$
Orbital Debris
Where are we today?

- 100 employees, headquarters in San Francisco, CA
- 100+ satellites manifested over next 18 months
- $160 Million raised, mostly via VC
- 20 satellites currently operating
- 1000’s of images downloaded per day
- Expanding the in-orbit constellation
- Developing the imagery platform
Applications – Urbanization
Applications – Resource Extraction
Applications – Alternative Energy
Applications – Maritime Monitoring
Questions?