DMC3 and Carbonite-1: Two Sides of Small Satellites

6th of August, 2016 – Logan, Utah, USA
SSC16-III-10

Nimal Navarathinam
n.navarathinam@sstl.co.uk
Surrey Satellite Technology Ltd.
Launch of Two Different Classes of Spacecraft

- July 2015 saw the launch of two different classes of small satellites from SSTL:
  - High fidelity performance SSTL S1 spacecraft as used on the Disaster Monitoring Constellation 3 (DMC)
  - High utility spacecraft designed for very low cost and rapid schedule missions as demonstrated on Carbonite-1

- Both classes of spacecraft provide high resolution imagery and have been fully operational for over a year

- The satellites were all launched on-board a PSLV from Sriharikota, India into a SSO with an altitude of 651 km and an LTAN of 10:30
Comparison of S1 and Carbonite

**SSTL S1**
- DMC3 uses the SSTL S1 platform based on the tried and tested basic layout of the SSTL-300 (as on NigeriaSat-2), adding a new high resolution payload and more advanced avionics.
- SSTL S1 spacecraft is fully redundant and designed for triple-launch configuration on most popular small launcher fairings.

**Carbonite-1**
- Carbonite-1 platform is similar in size to the heritage SSTL-100 platform but the main difference is the structure is built around the telescope using central shear walls made of milled aluminum.
- Utilizes single string (except for receivers) architecture based on reliable heritage equipment.
- Carbonite Series also allows video imaging.

<table>
<thead>
<tr>
<th>Spacecraft</th>
<th>Carbonite-1</th>
<th>S1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Lifetime</td>
<td>1 year</td>
<td>7 years</td>
</tr>
<tr>
<td>Mass</td>
<td>86 kg</td>
<td>447 kg</td>
</tr>
<tr>
<td>Envelope</td>
<td>0.6 × 0.7 × 0.9 m</td>
<td>3 × 1.35 × 0.65 m</td>
</tr>
<tr>
<td>Payload Data Storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Volume</td>
<td>16 GBytes</td>
<td>554 GBytes</td>
</tr>
<tr>
<td>Imager Overview</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSD</td>
<td>1.5 m Colour imagery and video</td>
<td>1 m PAN</td>
</tr>
<tr>
<td></td>
<td>~5 km</td>
<td>4 m Multispectral</td>
</tr>
<tr>
<td>Swath</td>
<td></td>
<td>22.5 km</td>
</tr>
<tr>
<td>Payload Data Downlink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency Band</td>
<td>X-Band</td>
<td>X-band</td>
</tr>
<tr>
<td>Data Rate</td>
<td>80 Mbits/s</td>
<td>500 Mbits/s</td>
</tr>
<tr>
<td>Schedule</td>
<td>8 months</td>
<td>24 months</td>
</tr>
</tbody>
</table>
S1: Imaging Capability

- S1’s high agility not only supports off-axis imaging up to 45° from nadir, it also supports multiple imaging modes including:
  - Along-track stereo
  - Across-track stereo
  - Mosaic mode
S1: Imaging Capability (London)

Image over cloudy London, UK (courtesy of 21AT) from DMC3

- Buckingham Palace and London Eye
- O2 Arena and Canary Wharf

© 2016 by TripleSat

London, UK
S1: Current Status and Future Evolution

**Current Status**

- From Launch to May 2016, a total of 36139 scenes have been successfully captured and downlinked across the constellation.
  - This equates to 18.5 million km² captured in 10 months since launch; this is approximately twice the area of the US or nearly 76 times the area of the UK.
  - A total of 44.5 TBytes of imager data has been generated. As of

- For June 2016 alone, a total of 15617 scenes have been captured and downloaded across the constellation in 1 month
  - Approximate 7.98 million km² (~80% of the area of US) and generated 19.2 TBytes of data

**Future Evolution**

- SSTL has enhanced the design of the S1 imager so that for future missions it will be possible to achieve sub-meter imagery down to a native (i.e. without processing) GSD of 0.7m.

- The imager was designed to be modified to achieve this while still maintaining the agility of the SSTL-300 platform.
Carbonite-1: Imaging Capability

First image captured over Dallas, Texas in July, 2015
Carbonite-1: Imaging Capability

- Nadir Imaging mode is a simple “point and click” mode where images are captured in rapid succession over a target.
- Images can be stitched together to show a film strip.
- ~5 km swath coverage provided and 40 km strip image made.
Carbonite-1: Imaging Capability (FMC)

• Forward Motion Compensation (FMC) mode allows for satellite to stare at one location as it moves over
• Images captured are stacked to create a video
• Motion of objects on ground can be tracked

Pittsburgh, USA
Carbonite-1: Current Status and Future Evolution

**Current Status**

- As of June 2016, Carbonite-1 has captured and downloaded more than 975 GBytes of raw data; equivalent to more than 65000 images.

- As a prototype, the main objectives of the mission were to demonstrate the rapid build capability and the low cost of the final product. The mission has been a complete success and has in many cases surpassed the original expectations.

**Future Evolution**

- The satellite is the first in a series of demonstrators that will have increasing performance while bringing down cost and time to build.

- The next satellite will incorporate new on-board data processing capability and demonstrate several new material technologies, including additive layer manufactured parts and new deployment systems.
Concluding Remarks

- The S1 and Carbonite Series of spacecraft are two sides of the same coin: one provides high fidelity imagery and the other provides high utility; but they both provide high resolution imagery.

- S1 provides high precision pointing in order to acquire images with a high degree of fidelity with respect to the scene being captured.

- The Carbonite Series of spacecraft provide high utility by reducing the cost of entry for new and existing business models which includes the deployment of super-constellations. In addition, it includes video capture capability.
Thank You!

Nimal Navarathinam
n.navarathinam@sstl.co.uk
Carbonite-1: Imaging Capability (FMC)

- Forward Motion Compensation (FMC) mode allows for satellite to stare at one location as it moves over
- Images captured are stacked to create a video
- Motion of objects on ground can be tracked
Carbonite-1: Dubai, UAE

- Burj Al Arab
- Wild Wadi Water Park
- Jumeirah Beach
- Beach Umbrellas

Google Maps