Watching the world go by...

SSC-II-08

Alex da Silva Curiel

Andrew Haslehurst, Kieran O’Brien, Nimal Navarathinam, Simon Prasad, Chris Saunders, Rachel Bird, Liam Sills, Andrew Cawthorne, Luis Gomes, Martin Sweeting
“NewSpace” constellation initiatives

- LEOcomms
- m2m comms
- Hires optical
- Meteo
- Science
- Medium resolution
- Radar
- intersat
- Tracking
- Hires optical and video
- Mixed
- Microgravity
- MEOcomms
- Atmos gasses
- Interference
- Infrared
- Hyperspectral

Aug 2018

©2018 SSTL

119 small satellite constellations planned
Video Imaging Rationale

- Video has additional information content:
- Desire to monitor human scale activity
  - Require relatively high resolution
  - Highly responsive or 24/7
  - Few frames per second
  - Target track or intelligent control
- Technology Push
  - Video technology widely available
  - Processing in the Cloud
  - Information access through mobile devices

- Applications
  - News and media
  - Maritime Surveillance
  - Border Surveillance
  - Environmental Surveillance
  - Economic analytics
  - 3D mapping
  - Insurance
  - Disaster response
  - Cloud avoidance
Why is it difficult?

1. Ultra-low cost satellite
2. Minimal mass/volume
3. Long lifetime
4. Batch production compatible

High Spatial resolution
High Temporal resolution
Low CAPEX (Emerging market)
Carbonite-1 (Jul 2015)

1. Proof of concept
2. “good enough” imagery
3. Ultra-low CAPEX
4. Capacity/CAPEX ratio to permit adequate returns

- EO technology demonstration
- KO to completion of manufacture within 8 months
- Core team of just 4 people
- ~90kg, 620km SSO
- ~45,000 scenes in first year
Carbonite-2 (Jan 2018)

3D printing
Additive design technologies
Evolutionary design techniques

CFC Telescope
+ Star Camera
+ 2x deployable panels
+ 16x data storage

100 kg
Wet mass

500 km
Orbit

5x5 km
Swath

RGB
Spectral Bands

25 FPS

1 m
GSD
Carbonite 2 - early results

Example videos from the SSTL Carbonite-2 mission

https://www.sstl.co.uk/CARBONITE-2-videos
Carbonite 2 - early results
Rapid Revisit Video Imaging Constellations

Various possible scenarios with increasing dwell times:

<table>
<thead>
<tr>
<th>Scenario</th>
<th># Satellites</th>
<th># Orbital planes</th>
<th>Lat 20° revisits per day</th>
<th>Lat 50° revisits per day</th>
<th>Maximum video (minutes)</th>
<th>Average video (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Daily opportunities”</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>“several daily opportunities”</td>
<td>12</td>
<td>3</td>
<td>0-2</td>
<td>2-3</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>“30min intervals”</td>
<td>24</td>
<td>3</td>
<td>3-5</td>
<td>4-6</td>
<td>4.6</td>
<td>3.3</td>
</tr>
<tr>
<td>“Prolonged observation”</td>
<td>36</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>“regular intervals”</td>
<td>36</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>19</td>
<td>5</td>
</tr>
<tr>
<td>“Prolonged observation”</td>
<td>72</td>
<td>3</td>
<td>&gt;1</td>
<td>&gt;1</td>
<td>52</td>
<td>35</td>
</tr>
<tr>
<td>“Prolonged observation”</td>
<td>135</td>
<td>3</td>
<td>1-2</td>
<td>1-3</td>
<td>96</td>
<td>50</td>
</tr>
<tr>
<td>“Dedicated and focused observation”</td>
<td>163</td>
<td>9</td>
<td>Multiple</td>
<td>Multiple</td>
<td>264</td>
<td>n/a</td>
</tr>
<tr>
<td>“constant surveillance”</td>
<td>484</td>
<td>22</td>
<td>2 minute global revisit</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Video MegaConstellation – “Walls of Coverage”

- 484 satellites - 22 planes of 22 satellites
- 500 km sun-synchronous orbit
- Not traditional Walker – planes are spread between LTANs of 08:00 to 17:00 (6.13 degs)
  - Creates wall of sensor coverage over sunlit part of earth’s surface
  - Provides global revisit time ~ 2 mins
Video imaging constellations
1. Now becoming feasible with small satellite technology
2. Requires high temporal and spatial resolution, at low cost
3. Data return is still a major challenge for a low cost smallsat
4. Design for automated manufacture and test essential for operational systems