Networking Friday Thematic Special Session on Nanosatellites

Satellites and Small Satellites at INPE, Brazil

MILTON KAMPEL, INPE
milton.kampel@inpe.br

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Who we are?

EARTH SCIENCES

Space Engineering, Technology and Science
Small Satellites Division

http://www.inpe.br/institucional/sobre_inpe/instalacoes.php#sede35
### Cameras

<table>
<thead>
<tr>
<th>Type</th>
<th>MUX</th>
<th>WPM</th>
<th>WFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Brazil</td>
<td>China</td>
<td>Brazil</td>
</tr>
<tr>
<td>Type</td>
<td>Push broom</td>
<td>Push broom TDI</td>
<td>Push broom</td>
</tr>
<tr>
<td>Revisiting rate</td>
<td>31 days</td>
<td>31 days</td>
<td>5 days</td>
</tr>
<tr>
<td>Quantization</td>
<td>8 bits</td>
<td>10 bits</td>
<td>10 bits</td>
</tr>
<tr>
<td>Swath</td>
<td>95 km</td>
<td>92 km</td>
<td>684 km</td>
</tr>
<tr>
<td>Band 1</td>
<td>0.45 - 0.52 µm</td>
<td>0.45 - 0.52 µm</td>
<td>0.45 - 0.52 µm</td>
</tr>
<tr>
<td>Band 2</td>
<td>0.52 - 0.59 µm</td>
<td>0.52 - 0.59 µm</td>
<td>0.52 - 0.59 µm</td>
</tr>
<tr>
<td>Band 3</td>
<td>0.63 - 0.69 µm</td>
<td>0.63 - 0.69 µm</td>
<td>0.63 - 0.69 µm</td>
</tr>
<tr>
<td>Band 4</td>
<td>0.77 - 0.89 µm</td>
<td>0.77 - 0.89 µm</td>
<td>0.77 - 0.89 µm</td>
</tr>
<tr>
<td>Band 5 (PAN)</td>
<td>0.45 - 0.90 µm</td>
<td></td>
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</tr>
<tr>
<td>Resolution</td>
<td>16 m</td>
<td>2 m, 8 m</td>
<td>55 m</td>
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</tbody>
</table>

### Sun synchronous orbit
Altitude = 628 km
Inclination = 97.89°
Revisiting rate = 31 days
Descending node at 10h30 local time
Launch: 20th Dec. 2019
Commissioning: Aug/2020
Networking Friday on Nanosatellites

CBERS-04A WPM
PAN 2m & BGR 8m
13/AUG/2020
Itaorna, Nuclear Power Plant
http://www2.dgi.inpe.br/catalogo/explore

Courtesy: Laercio Namikawa
Amazonia-1
First MMP mission
Payload WFI camera
Forest monitoring
Launch: 28/FEB/2021

Amazonia 1 in the integration hall at the SHAR launch base in India
Satellite Tracking & Control

Alcântara

New antenna in CBA

Cuiabá

Courtesy: Mauricio Ferreira; http://www.inpe.br/crc/
Integration and Testing Laboratory (LIT)
Integration and Testing Laboratory (LIT)
Scenario of small satellites
# Ecosystem of small satellites

<table>
<thead>
<tr>
<th>Academy</th>
<th>Research, Innovation &amp; Development</th>
<th>Industry</th>
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</thead>
<tbody>
<tr>
<td><img src="UFSM" alt="Image1" /></td>
<td><img src="INPE" alt="Image2" /></td>
<td><img src="VISIONA" alt="Image3" /></td>
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<tr>
<td><img src="UnB" alt="Image4" /></td>
<td><img src="LIT" alt="Image5" /></td>
<td><img src="CRON" alt="Image6" /></td>
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<td><img src="DFC" alt="Image7" /></td>
<td><img src="CEI" alt="Image8" /></td>
<td><img src="ORBITAL" alt="Image9" /></td>
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<tr>
<td><img src="UnABC" alt="Image10" /></td>
<td><img src="IMST" alt="Image11" /></td>
<td><img src="VERMONT" alt="Image12" /></td>
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</tbody>
</table>

**Funding Agencies**

- AEB
- FAPESP
- CNPq
- CAPES
- Finep
- FUNCATE
- MCTIC

**Services / Applications**

- Earth observation
- Communication
- Earth observation
- Earth observation

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Courtesy: ACarlos Pereira
Bases for Production & Requirements

As is:

To be:

Courtesy: ACarlos Pereira
Entrepreneurship training

Center for incubation of technology-based companies on nanosatellites
Demand Creation

➢ Mission programs to leverage nanosatellite R&D
➢ Collaboration models
➢ CubeDesign
What the ‘Atlantic’ EO community needs

Empowered experts

Shared knowledge

Cloud platforms

APIs

In situ observations

Multi satellite data

Adapted from GEO/GCamara
What else?

Education

Outreach

Geo-Tools

R&D&I

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Acknowledgments

Antonio Carlos Pereira
Head of Small Satellites Division

Ivan Barbosa
Data Infrastructure and Supercomputer Coordinator

Mauricio Ferreira
Satellite Tracking, Control and Reception Coordinator

Laercio Namikawa, Walter A. Santos
Senior Technologists

Marco Chamon
Planning, Budget and Evaluation Coordinator

milton.kampel@inpe.br
Regarding the questions raised by André…

• What are your thoughts on the capabilities of Nanosatellites versus their larger brethren? Can they compete in terms of performance (e.g. resolution of remote sensing payloads? Communication capabilities? Precision of ADCS?)? are they mostly complementary / good for surge capacity? Can we envisage them (e.g. a large ensemble) replacing a single larger satellite anytime soon?

• Where do we start to draw the line on development using academic engineering processes or “light” / tailored standards versus application of full-blown space standards with all the associated system engineering artefacts? Is this a binary decision based on size? Or on orbit? Or is this more flexible?

• Constellations have been for some time quite an interesting subject and while it may be easier to fund one if there is a “strong” business case behind, how do you see possible collaborations and governance models for constellations that involve multiple countries / entities? Is it better to have a sort of non-profit entity that coordinates on behalf of all interested parties? Or a private for-profit company? Are scientific/environmental monitoring objectives compatible with a more commercially driven approach?

• Finally, any advice to nations that are not as advanced in their space programmes on how to get involved and develop a NanoSatellite development/integration/launch capability? Does it even make sense to do so or is it better to just go out and buy CubeSat kits?