Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

A Constellation of CubeSats for Amazon Rainforest Deforestation Monitoring

Fernanda Cyrne
Pedro Beghelli
Iohana Siqueira
Lucas Meneses
Rafael da Silva
Chantal Cappelletti

December 7, 2017

Universidade de Brasília

Faculdade UnB Gama

1. Amazon Rainforest
2. Deforestation
3. Mission Goals
4. Requirements
5. Orbit Characteristics
6. Payload
7. Satellite Bus
8. Actuation System
9. Next Steps
10. Conclusions

Universidade de Brasília

Faculdade UnB Gama

Amazon Rainforest

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

- The Amazon represents over half of the planet's remaining rainforests.
- The largest and most biodiversity tract of tropical rainforest in the world.
- Actually is monitored by brazilian government using a free database.

Figure: Limits of Amazon rainforest.

Universidade de Brasília — Faculdade UnB Gama

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

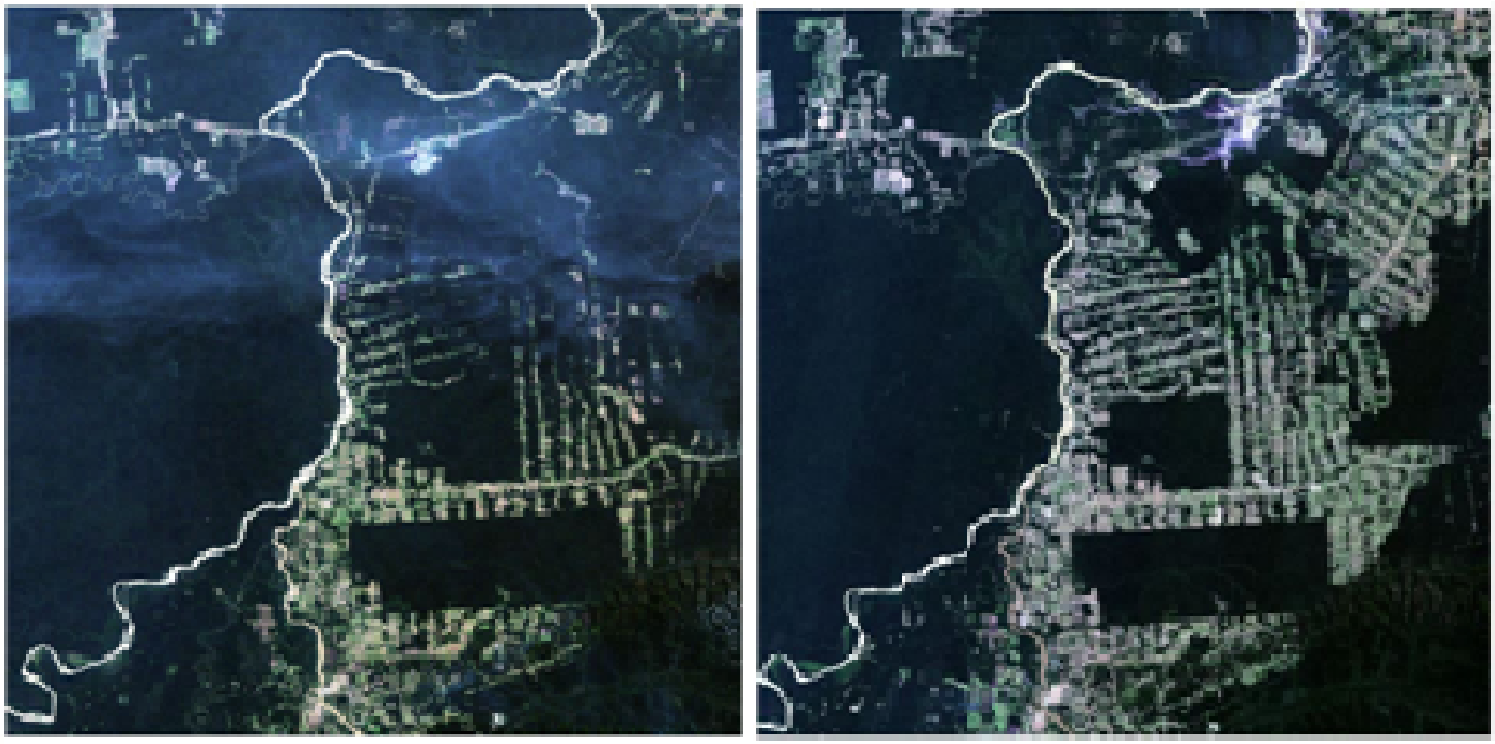


Figure: A comparison between the years 2002 and 2017.

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

- Develop a new system to identify new methods of deforestation in Brazilian Amazon Rainforest.
- Advance the capability of University of Brasília to design, develop and operate small satellites.
- Provide educational opportunities related to aerospace missions, satellites design and project management.

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

- A functional spacecraft shall be designed.
- Minimum spatial resolution less then 16 meters.
- RGB and NIR range.
- Maximum revisit time of 16 days.
- Images taken from the same place shall have similar illumination conditions.
- Low cost mission.

Orbit Characteristics

- The resultant orbit is a sun-synchronous circular orbit.
- Will be necessary 10 satellites in the constellation, that provides 13 days of revisit time.

Table: Orbital characteristics.

Altitude	$500 km$
Inclination	$97.40 degrees$
Orbital Period	$95.55 min$
Swath	$7.7 km$
Spatial Resolution	$15 m$
Orbital Velocity	$7.53 km/s$

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

- The selected payload is a Multispectral Camera - Red/Green/Blue/NIR - USB3, from Spectral Devices, that attends all requirements.

Table: Specifications of the payload

Interface	*USB*3
Maximum Bit Depth	12 *bits*
Number of Channels	4 *bands*
Pixels Per Channel	512*x*512
Dimensions	52*x*46*x*56 mm^3

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

Table: Results in the calculation of data generated

Data Generation Characteristics	
V_g	$6.98 km/s$
D_g	$7.65 Gb/orbit$
N	$15.07 orbits/day$
D_T	$115.29 Gb/day$

as V_g = relative ground velocity
D_g = generated data per orbit
N = number of orbits per day
D_T = generated data per day

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

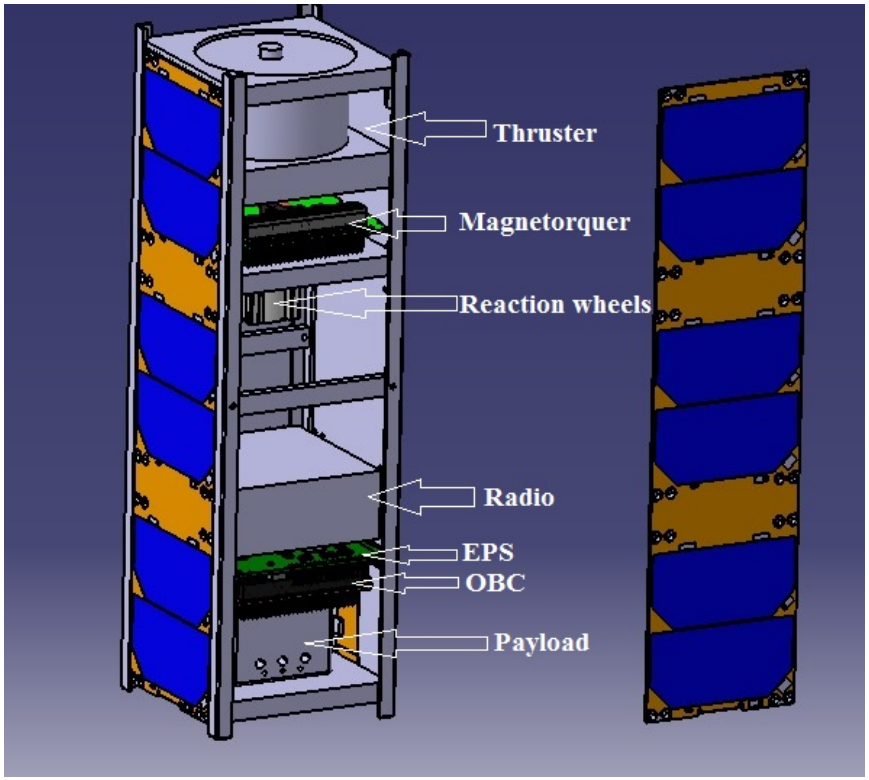


Figure: CubeSat 3U

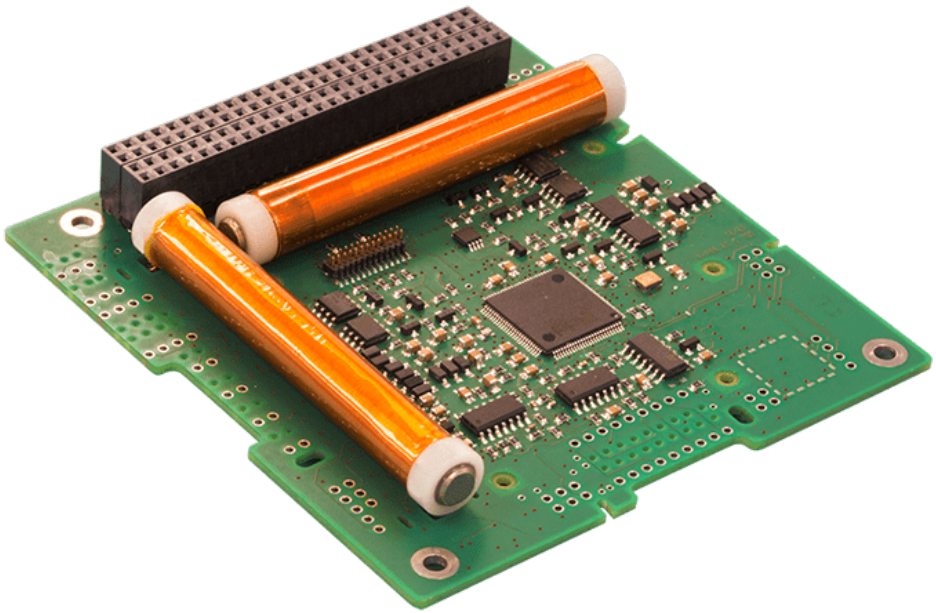
Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

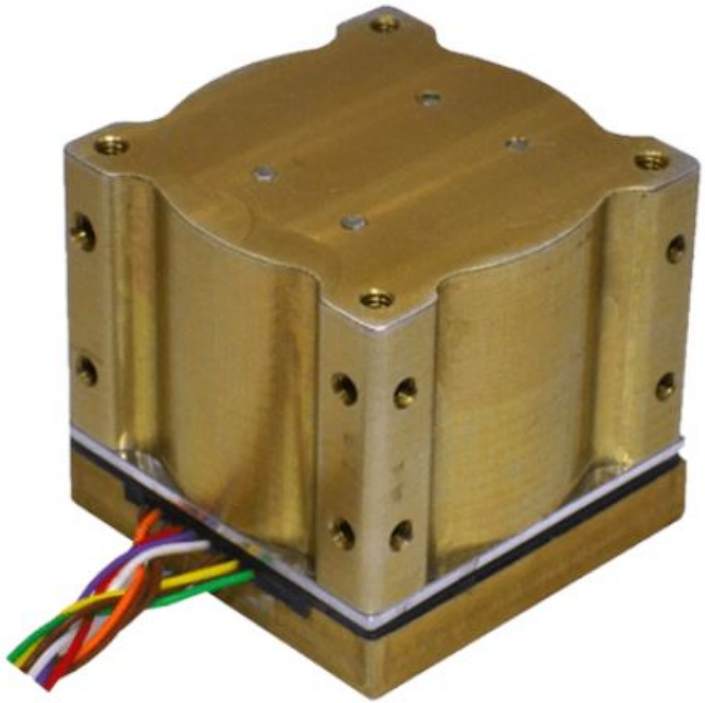
- The reaction wheel selected, based on the sum of disturbance torques from table, was CubeWheel Small from CubeSpace.
- A magnetorquer will be used to de saturate the reaction wheels and de tumbling. We selected a magnetorquer board from ISIS.

Table: Disturbance Torques acting on the CubeSat.

Disturbance Torque	Magnitude (Nm)
Gravity Gradient	$2.1356 \cdot 10^{-8}$
Solar Radiation	$2.1872 \cdot 10^{-10}$
Aerodynamic	$1.7386 \cdot 10^{-7}$
Magnetic Field	$9.7856 \cdot 10^{-6}$

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions





Universidade de Brasília

Faculdade UnB Gama

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

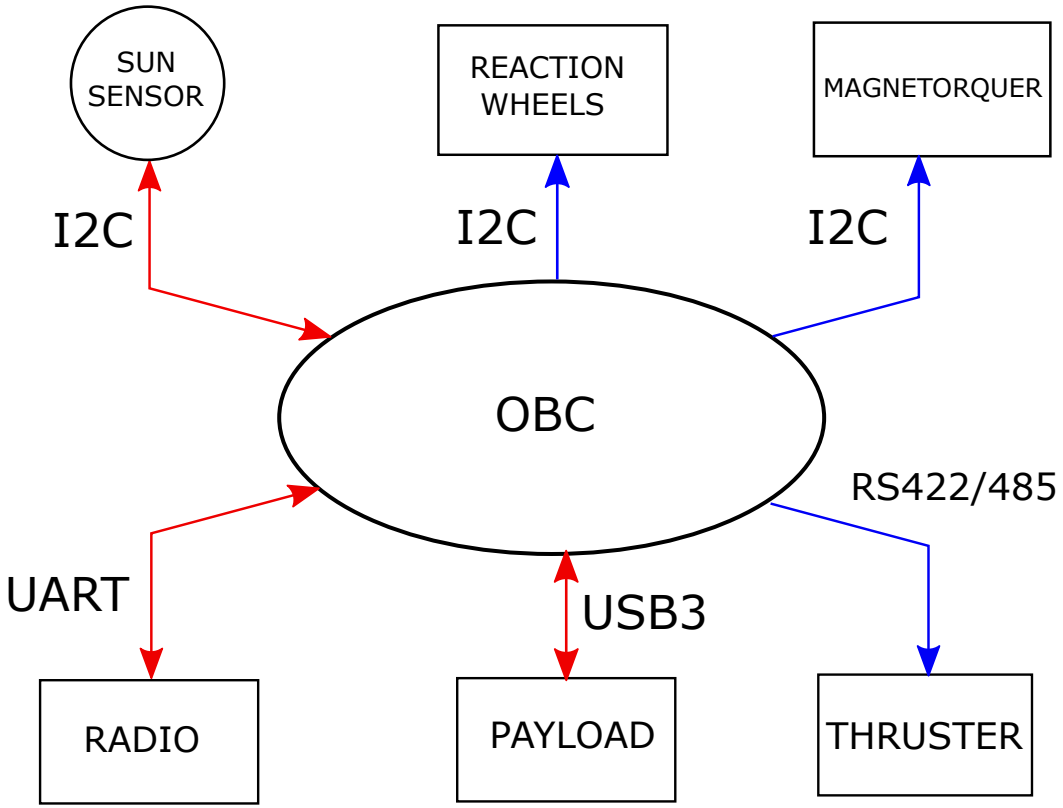


Figure: OBC Diagram.

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

- This system will be composed by solar panels as sources, rechargeable batteries, a battery charger regulator and a system distribution.

Table: Power Budget

Component	Cycle %	Peak (mW)	Average (mW)
Radio Receiver	100	5500	5500
Radio Transmitter	5	11000	550
Radio Beacon	100	300	300
OBC	100	660	660
Payload	5	4500	225
Reaction Wheels	30	600	180
Sun Sensor	100	13.4	13.4
Magnetorquer	10	1200	120
Thruster	10	40000	4000
Total		= 63773.4	= 11548.4

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

- More detailed description of subsystems.
- Launch and Ground Station selection.
- Complete documentation of phase B.
- Funding to initiate phase C.

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

- Nowadays monitoring satellites can not identify the new trend of deforesting small areas.
- 10 CubeSats in a constellation will be enough to achieve requirements.
- Revisit time of 13 days and spatial resolution of 15m.
- The project presented here was just pre phase A, phase A and beginning of phase B.

Universidade de Brasília Faculdade UnB Gama

Amazon Rainforest
Deforestation
Mission Goals
Requirements
Orbit Characteristics
Payload
Satellite Bus
Actuation System
Next Steps
Conclusions

Thank You!

UnB

fernandacyrne@gmail.com
beghelli.pedro@gmail.com

Universidade de Brasília

Faculdade UnB Gama