NANO SATELLITE CONSTELLATION FOR ENVIRONMENTAL DATA COLLECTION

CONASAT - 0
Summary of Functional Requirements

Version 01

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Property Registration Document

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1. Scope

This document defines the architecture and functional requirements of the mission CONASAT-0, to be held by its payload (the DCS transponder), defining the requirements of the platform on which it will be shipped.

2. The Brazilian System of Environmental Data Collection - SBCDA

The Brazilian System of Environmental Data Collection (SBCDA) was conceived with the objective of providing the country with a collection of satellite data for various applications, such as monitoring of catchment areas, weather and climate forecasting, study of ocean currents and of atmospheric chemistry, pollution control, forecasting to combat disasters, assessing the potential for renewable energies like wind, solar, and provide environmental data for scientific research. Figure 1 illustrates the information flow in the system.

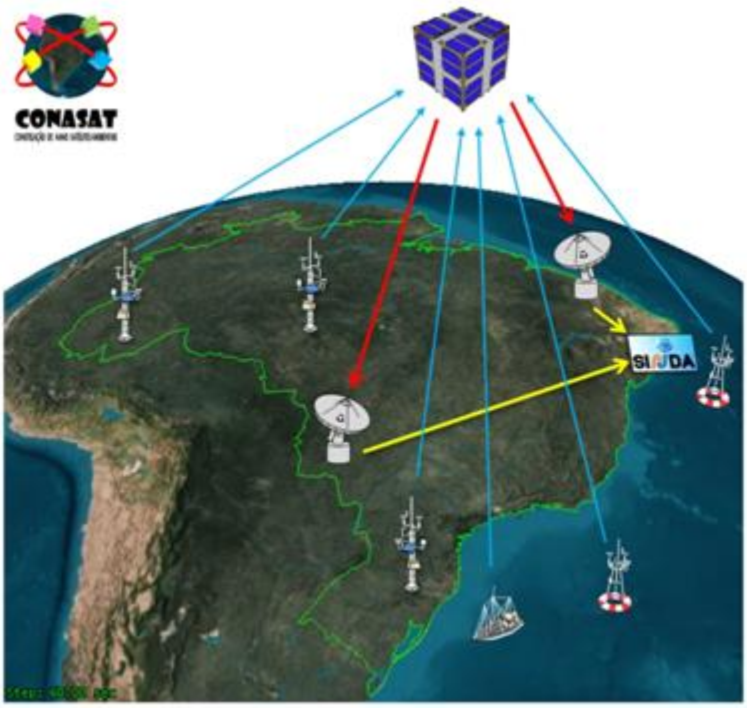

Figure 1. The Brazilian System of Environmental Data Collection

The SBCDA is basically composed by Environmental Data Collection Platforms (PCD), distributed throughout the national territory, as well as offshore platforms. Each PCD features suitable for your specific application (temperature, moisture, river flow, wind speed, etc.) sensors. The collected data are periodically updated and stored and transmitted repeatedly every 200 seconds on average, in a transmitter frequency of

401.62 MHz. This repetition is needed, because the PCD does not have the ability to detect if there are any available satellite to receive their transmission. This invariably creates a multitude of receptions of the same data, which is treated in the receiving stations.

The space segment of SBCDA is currently composed of the SCD1 and SCD2 satellites, launched respectively in 1993 and 1998, in circular 750 km altitude orbits in an orbital plane tilted 25 ° to the equator. With each pass of the satellite transmissions are received from the PCD in his sight, which are translated to the frequency of 2,267.52 MHz and relayed back to earth to the receiving stations.

The ground segment consists of the receiving stations of Cuiabá, MT and Alcantara, MA in charge of tracking satellites, receive the data transmitted by them and direct them to the Mission Control Center in Natal, RN where the data is processed and stored for consultation by the end users of the system.

3. CONASAT Project

The main objective of CONASAT Project is to provide a solution to ensure continuity of SBCDA through a constellation of nano satellites using the CubeSat standard.

The payload of the satellite is the DCS transponder, being developed by INPE / CRN.

4. The first version CONASAT-0

The CONASAT-0 version will be the proof of concept of the project and its main task will be to validate the operation of the DCS transponder. For this, the platform should be as simple as possible.

5. General Requirements of CONASAT-0

5.1 Structure

Should be adopted the standard of compatible size CubeSat platform that meets their own needs and payload. The structure shall conform to the standard set in the document CubeSat Design Specifications - Rev.13, California Polytechnic State University.

5.2 Orbit

For the CONASAT project as a whole were considered the altitude and inclination of the orbit to achieve a desired time to revisit. In this first CONASAT-0 version, because it is a proof of concept, will not be considered the orbital requirement.

The orbit to be chosen should be the one commonly used by CubeSats (circular low orbit - LEO). This choice should be such that the decay time of the satellite is greater than your time shorter than the lifetime limit (2 years) and defined by international Debris codes, which is 25 years after the end of the lifetime.

5.3 Electric Power Subsystem

This subsystem should be able to meet the electricity demand of the entire avionics platform and payload.

The payload is powered by two voltages:

- +5 V with a power of 3.4 W.
- +3,3 V with a power of 600 mW.

The power system must have the ability to turn on and off the supply voltages of the payload (+5 V and +3.3 V) via commands from the onboard computer.

For sizing of the energy demand of the payload is taken as the basis that this only operates during periods of orbit is targeting a receiving earth station in the land or the PCD. As the orbit will be possibly a polar, due to the great amount of market offers, we have only 2 or 3 daily useful sights, with an average time coverage of 10 minutes.

5.4 Payload (DCS Transponder)

It is responsible for receiving the signals sent by the Data Collection Platforms at a frequency of 401.62 MHz, at a range of -98 dBm to -123 dBm, and resend them back to receiving stations, frequency of 2,267.52 MHz. It is composed of 3 boards with specific functions:

- Board 1 - Input - reception, amplification, filtering and processing of RF
- Board 2 - Digital Processor - digital processing in FPGA
- Board 3 - Output - treatment, modulation and amplification of RF power

These boards use the CubeSat Kit standard, using the 104 pin bus. Thus, the platform shall be provided with mechanical attachment to these boards and electrical interface 104 pins bus. The distribution of signals in the connectors is shown in the document CNS-DCI-07-PY-001-V2 - Interface Control Document.

In addition to the connections via this bus, the baseband connections between the plates 1 and 2 and between 2 and 3, are made by direct cabling.

The connections with the antennas are carried by coaxial cables.

All communication between the transponder DCS subsystem and the onboard computer shall be taken by I^2C bus (CubeSat Kit 104 pin bus).

5.5 Tracking, Telemetry and Command Subsystem

Due to the facilities offered and availability, specific frequencies will be used within the amateur radio bands, for which there are control stations available. These links should operate:

- Telemetry – 145,865 MHz, BPSK, 4,8 Kbps, BER 1E-06
- Telecommand - approximately 439 MHz, AFSK, 1,2 Kbps, BER 1E-05

The protocol used should be the AX-25

Should be provided the telemetry relating to "housekeeping" (voltages, currents, temperatures and other), and remote controls necessary for proper operation of the platform. The document CNS-DCI-PY-07-001-V2 - Interface Control Document shows the lists of telemetry and telecommand specific to the payload.

5.6 Antennas

Complied the restrictions imposed by the CubeSat standard, there is no greater demands on the choice of the types of antennas adopted. Preferably omnidirectional antennas offer greater security operation in 4 communication links:

- Payload Uplink - UHF - 401,62 MHz
- Payload Downlink - S-Band - 2.267,52 MHz
- Telemetry Downlink - VHF - 145,865 MHz
- Telecommand Uplink - UHF - 439 MHz

5.7 Attitude Control Subsystem

The mission of CONASAT-0 is to exchange radio signals to the earth. For this we have to consider the radiation patterns of antennas adopted, which typically have large opening angle, causing the pointing requirements are low. This item is open to the proposal based on the requirements of the antennas and power generation solution.

5.8 OBDH Subsystem

In addition to managing the entire operation of the platform, it must have the ability to store programs and data sent from the land necessary for the operation of the periods in which the payload should operate.

5.9 Thermal Control

The thermal control to be adopted by the platform shall be such that, in addition to ensuring the proper operation, ensure the temperature of the payload operation between -30°C and +70°C.

6. Required Documentation

- Detailed satellite technical specification (components and subsystems)
- Interface between subsystems
- Interface between satellite and ground segment
- Development plan
- Procedures for AIT – Assembling, Integration and Tests (modules, subassemblies, equipment, etc.)
- Warranty and product quality
- Design detail (mechanical assembly drawings, details, layout, drilling, etc.)
- Reliability
- Radiation Analysis