Bolivian endeavours for space innovation—ChitiSat Project

UNITED NATIONS
Office for Outer Space Affairs

United Nations/Brazil Symposium on Basic Space Technology
"Creating Novel Opportunities with Small Satellite Missions"
Natal, Brazil, 11—14 September

Miguel G. Heredia—Email: miguel.heredia@abe.bo

Abstract

The launch of the first Bolivian satellite TKSAT-1 in 2013, marked an important milestone in Bolivia's history, as it represented its inclusion to space. On the other hand, through this historical event, young professionals and students become more interested in space technologies. As a result, Bolivian universities have gained interest in working with Small Satellites, as they are faster to develop and offer students hands-on experience in designing, developing, operating and testing within short timescales. The Bolivian educational small satellite *ChitiSat* is the first tangible project developed by the Higher University San Andres, which has started last year and still remains under study and integration.

Figure 1. TKSAT-1 mission, ground segment infrastructure and satellite manufacturing: A) Amachuma Ground Station—Satellite Control Center (SCC), Payload Control Center (PCC), and Teleport, for DTH and VSAT services management (La Paz—Bolivia); B) La Guardia Ground Station—back-up Satellite Control Center (SCC) (Santa Cruz de la Sierra—Bolivia) C) TKSAT—1 Satellite under construction and testing—The satellite carries 22 Ku—band, 2 C—band and 2 Ka—band transponders (China, 2013). D) TKSAT—1 luanching (China, 2013)

Introduction

In 2017 the first small satellite project was presented and initiated with the name of *ChitiSat*.

The objective of the *ChitiSat* project is determined to be completely educational. Its purpose is to provide hands-on experience of real satellite missions to students, young professionals, and institutes dedicated to space technology.

Description

The initial integration of the *ChitiSat* is composed by the following subsystems and components at a system level design:

The Payload Subsystem	
	VGA Video Camera
	ML8511—UV-A and UV-B sensor with a range 300nm. to 520 nm.
	LM35—External temperature sensor
Attitude determination and Control Subsystem	
	IMU GY521—Accelerometer, gyroscope and tempt. sensor
	BMP280—Barometer for altitude determination
	GY273—3D Magnetometer
Electrical Power Subsystem	
	Power board controller
	10 Whr Battery
On—Board Data Handling Subsystem	
	ARM Cortex M4 32bit MCU+FPU 128MB Storage SD card.
Communication Subsystem	
	SV651—433MHz On—board transceiver, GFSK mod. 9600 bit rate
	VHF On—board antenna. Frequency range: 433 MHz.
	MCU ArduinoPro Mini based on the ATMega328 family.
The Earth Station	
	SV651—433MHz transceiver. GFSK modulation. 9600 bps bit rate
	VHF antenna—Frequency 433MHz
	MCU ArduinoUNO based on the ATMega328 family.
	GUI interface, for data analysis.
Telemetry and Command Subsystem	
	SV651—433MHz On—board transceiver, GFSK mod. 9600 bit rate
	VHF On—board antenna. Frequency 433 MHz.
	MCU ArduinoPro Mini based on the ATMega328 family.
Structure to be determined	
TOTAL MASS (g): 540	

Table 1. Component specification per subsystem—Initial integration stage (July,2018)

One type of frame was devised, and is used for both states of transmission, TTC and payload, only varying the header. information.

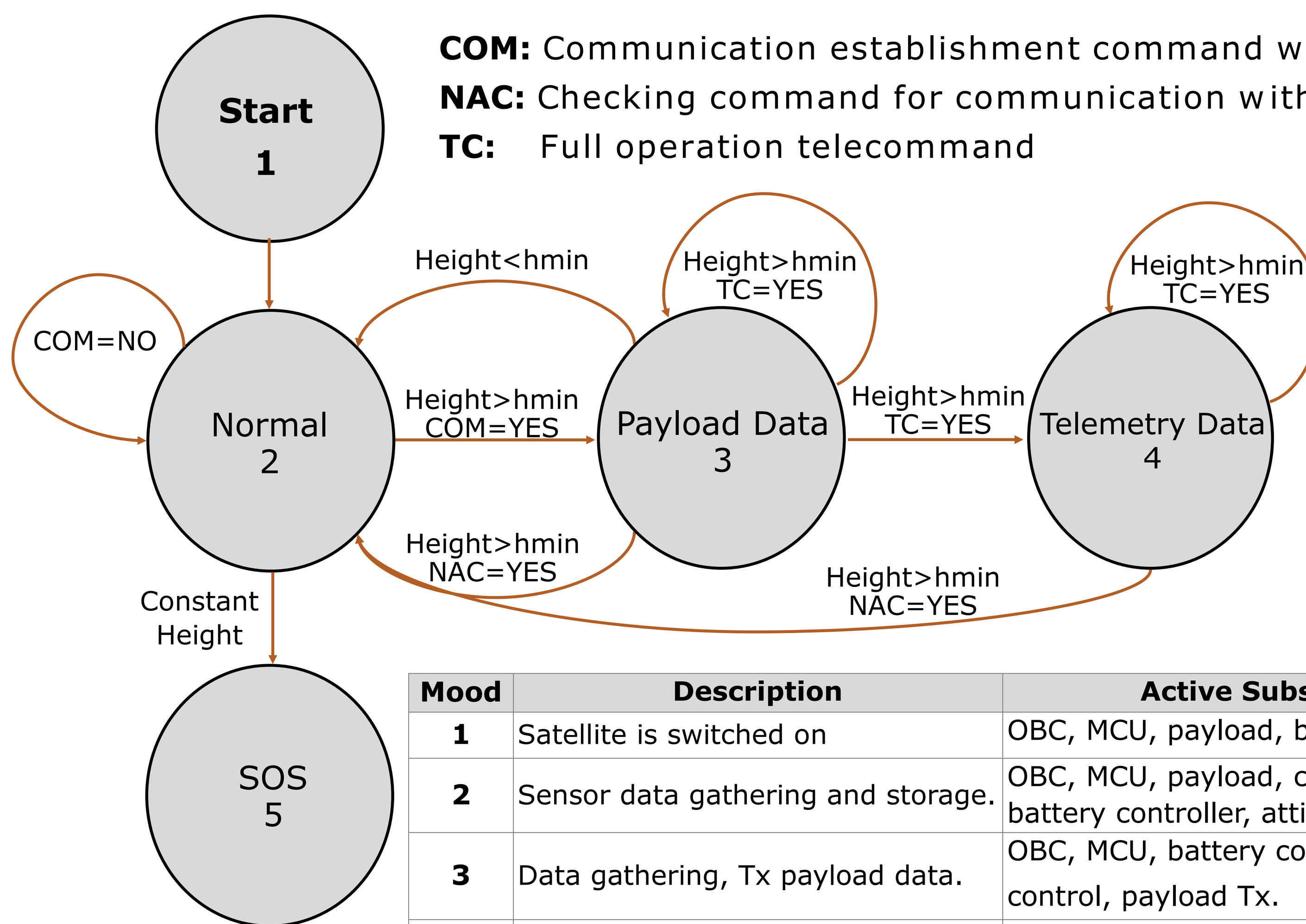
Start	Header	Data	Checksum	End
1	1	30	1	1

Payload data 0xD1 Header	
NAME	**Bits**
Magnetometer X, Y, Z	48
Accelerometer X, Y, Z	48
Gyroscope X, Y, Z	48
Barometer	20
Temperature 1, 2, 3	36
Current Sensor	12
Voltage Sensor	12
UV Sensor	16

TTC data 0xD2 Header	
NAME	**Bits**
Magnetometer X, Y, Z	48
Accelerometer X, Y, Z	48
Gyroscope X, Y, Z	48
Barometer	20
Temperature 1, 2, 3	36
Current Sensor	12
Altitude1, 2	32
Timer	16

Five different operation moods are implemented in the processor in order to determine the satellite's operation at different scenarios.

COM: Communication establishment command with the earth station.
NAC: Checking command for communication with the earth station.
TC: Full operation telecommand



Mood	Description	Active Subsystem	(mW)
1	Satellite is switched on	OBC, MCU, payload, battery controller.	4492
2	Sensor data gathering and storage.	OBC, MCU, payload, communication, battery controller, attitude control.	6411.7
3	Data gathering, Tx payload data.	OBC, MCU, battery controller, attitude control, payload Tx.	6411.7
4	Data gathering, Tx Telemetry data.	OBC, MCU, battery controller, receive command and telemetry data Tx, attitude control.	6411.7
5	OBC and sensors are switched off.	Communication subsystem.	2904.5

Figure 2. Satellite scenario with five operation moods and their estimated power consumption

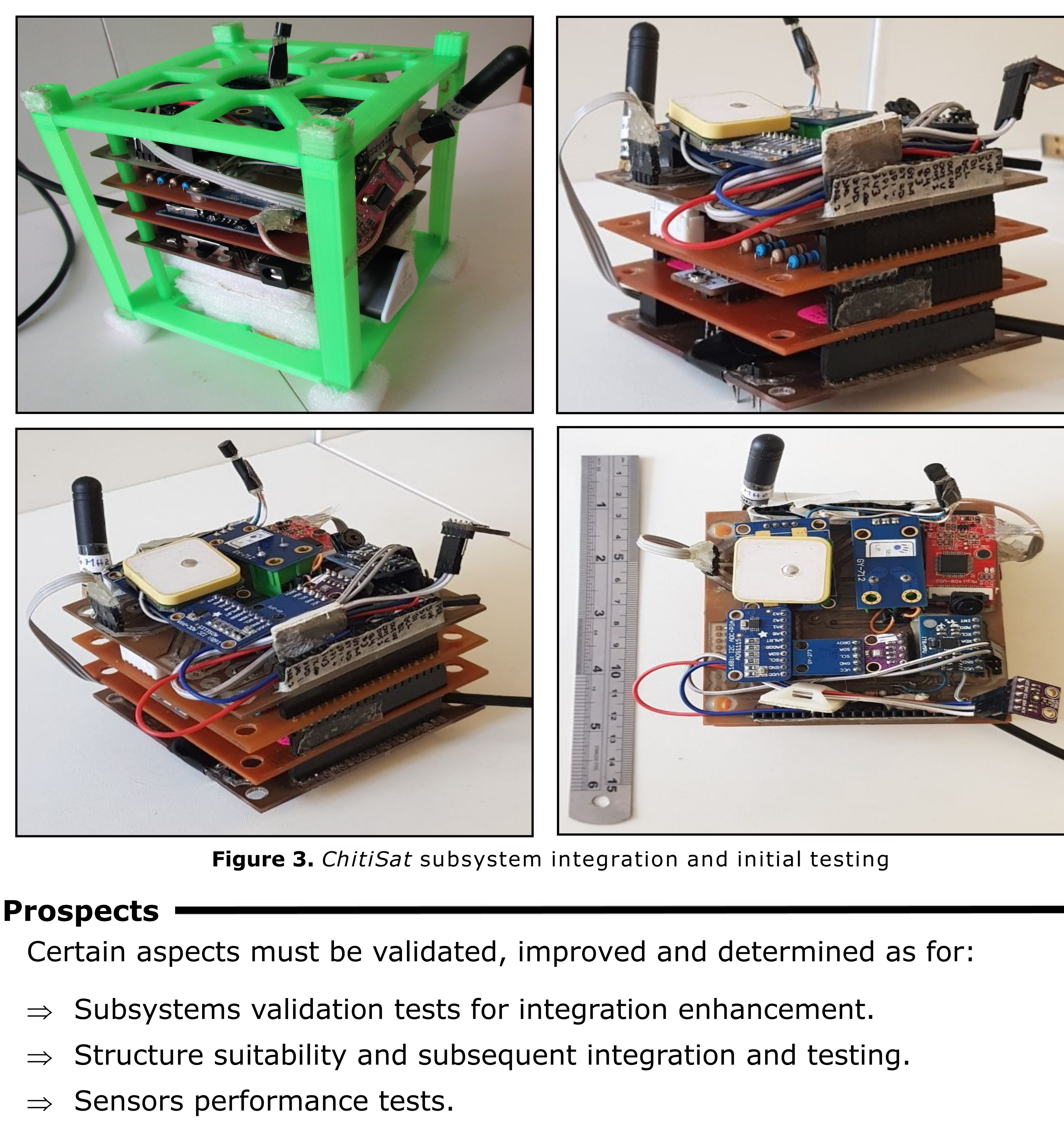


Figure 3. *ChitiSat* subsystem integration and initial testing

Prospects

Certain aspects must be validated, improved and determined as for:

- ⇒ Subsystems validation tests for integration enhancement.
- ⇒ Structure suitability and subsequent integration and testing.
- ⇒ Sensors performance tests.
- ⇒ Data validation and thorough analysis.
- ⇒ Type of launching.