MYSat

1U CUBESAT MISSION

UNIVERSITI SAINS MALAYSIA

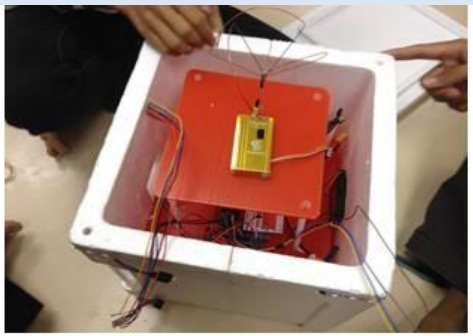
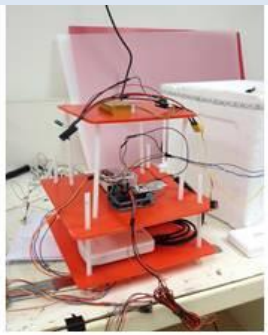
USM SPACE SYSTEM LAB
USSL

Presentation Overview

- Background
- Team members
- Mission Statement
- Mission Objectives
- Overall System

Project Background

- The USM Space Systems Lab (USSL) is a new group under the School of Aerospace, Universiti Sains Malaysia. The USSL encompasses research in near space, small satellite system, dynamics and control and space environment.

Capstone Design Project : High Altitude Balloon

- Hands-on experience in satellite sub-system
- Performing the project risk assessment, work breakdown structure, mission design and analysis before the physical spacecraft going to be tested, deployed and operated.
- Current research on autonomous control for payload retrieval system.

Project Background

- Current research - Modelling of the effect of electromagnetic phenomena in ionosphere over South East Asia region.
- Apply 2D FDTD method for modelling local Earth-ionosphere waveguide by solving full vector time domain Maxwell's equations of electromagnetic wave propagation. The model will be used to characterize ionospheric anomalies and geomagnetic perturbation over the Malaysia-Sumatera region's ionosphere .
- The measurement of electron density data from satellite is going to use to validate electromagnetic model developed from this research.

Project Background

Need for satellites (Oyama et al. 2010) :

- Ground base observation – limited to local area/region
- The accuracy of ionosonde and TEC insufficient to identify the epicentre, while satellite instrument can measure even small changes in plasma density.
- Continuous satellite data over the globe covering epicentre can provide clear picture of the development of pre-earth quake anomalous features.

Mission Statement

The atmospheric studies have been conducted all over the world using ground radar system, GPS receiver and space-borne such as satellite and launcher. Atmospheric parameter subject to atmosphere study are electron density, temperature and magnetic field that are sensitive to the variations of D, E and F layers of ionosphere. However, we are lacking of facilities such as satellite and ground radar that provided data for atmospheric studies specifically in South East Asia (SEA) region. The study and observation of ionosphere activity over the SEA is as important as any study conducted all over the world because the data from atmospheric studies can be used in disaster management such as precursor for earthquake and tsunami, lightning and typhoon location, volcanic eruption etc. Almost of 70% of SEA in on Pacific Ring of Fire, this data is very important since these natural disaster will affect the SEA region and a part of South Asia region and leave impact to socio-economics to the country respectively.

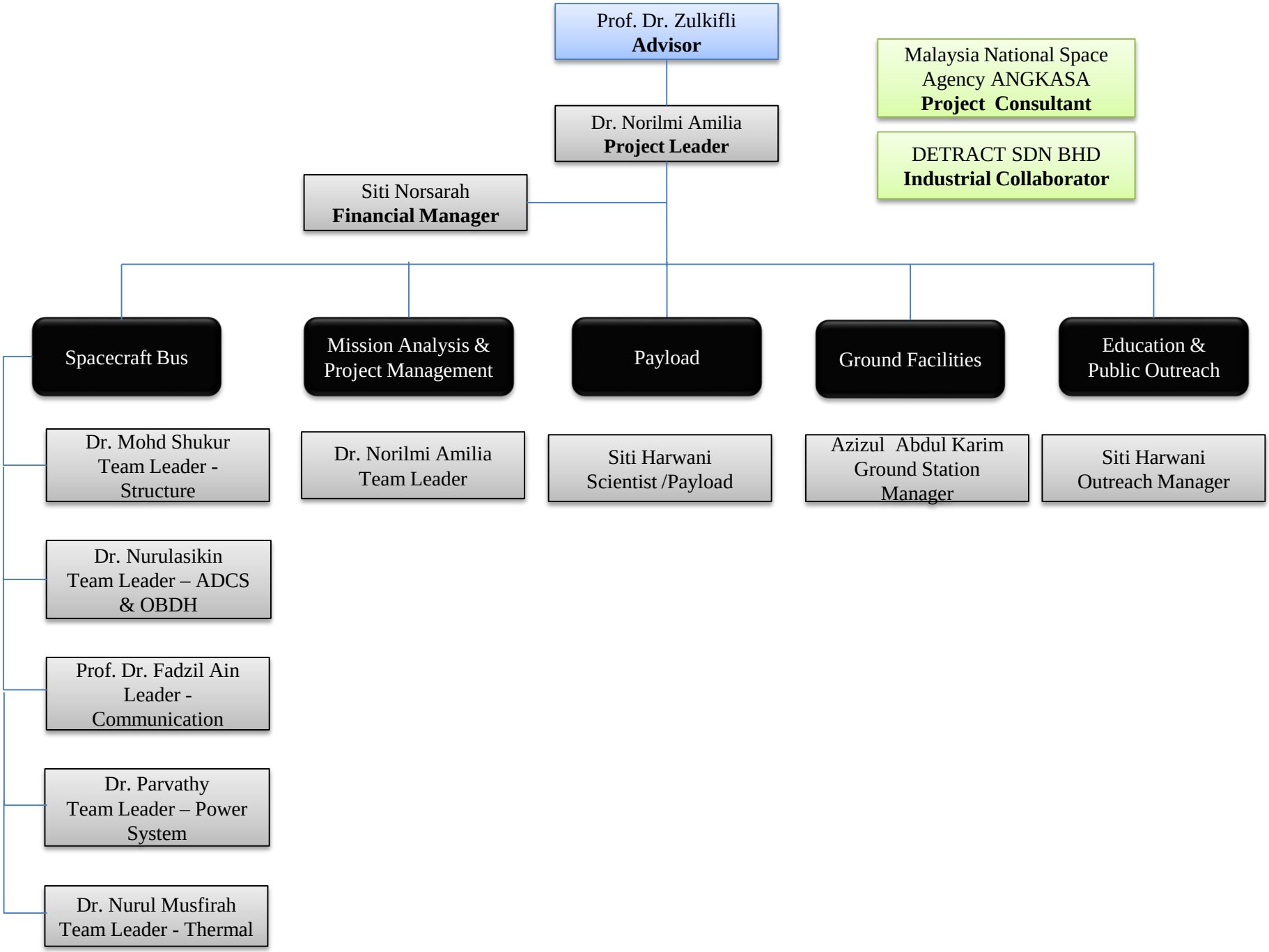
Primary Objective

- To measure electron density in E layer of ionosphere for validation of developed electromagnetic model and application in natural disaster management

Secondary Objective

- To develop university capabilities in developing a Nano-satellite
- To inspire and prepare future space-professionals by provide university students with practical experience in all aspects of a real space project and to enhance their motivation to work in the fields of space technology and science, thus helping to ensure the availability of a suitable and talented workforce in the future

Team members


Prof. Dr. Zulkifli
Advisor
Malaysia National Space Agency ANGKASA
Project Consultant
Dr. Norilmi Amilia
Project Leader
DETRACT SDN BHD
Industrial Collaborator
Siti Norsarah
Financial Manager
Spacecraft Bus
Mission Analysis & Project Management
Payload
Ground Facilities
Education & Public Outreach
Dr. Mohd Shukur
Team Leader - Structure
Dr. Norilmi Amilia
Team Leader
Siti Harwani
Scientist /Payload
Azizul Abdul Karim
Ground Station Manager
Siti Harwani
Outreach Manager
Dr. Nurulasikin
Team Leader – ADCS & OBDH
Prof. Dr. Fadzil Ain
Leader - Communication
Dr. Parvathy
Team Leader – Power System
Dr. Nurul Musfirah
Team Leader - Thermal

Overall System

Technical Features

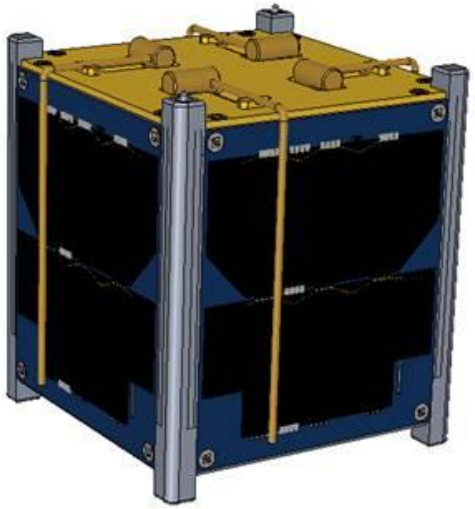
MYSat	
Orbit	Low Earth Orbit
Altitude	380 - 420 km
Inclination	51.6 deg
Lifetime	6 months
Communication	2 Mbit max/day (UHF/VHF)
Average Power	2 Watt
Mass	1.218 kg (10 x 10 x 10 cm)
Instrument	Multi needle Langmuir Probe

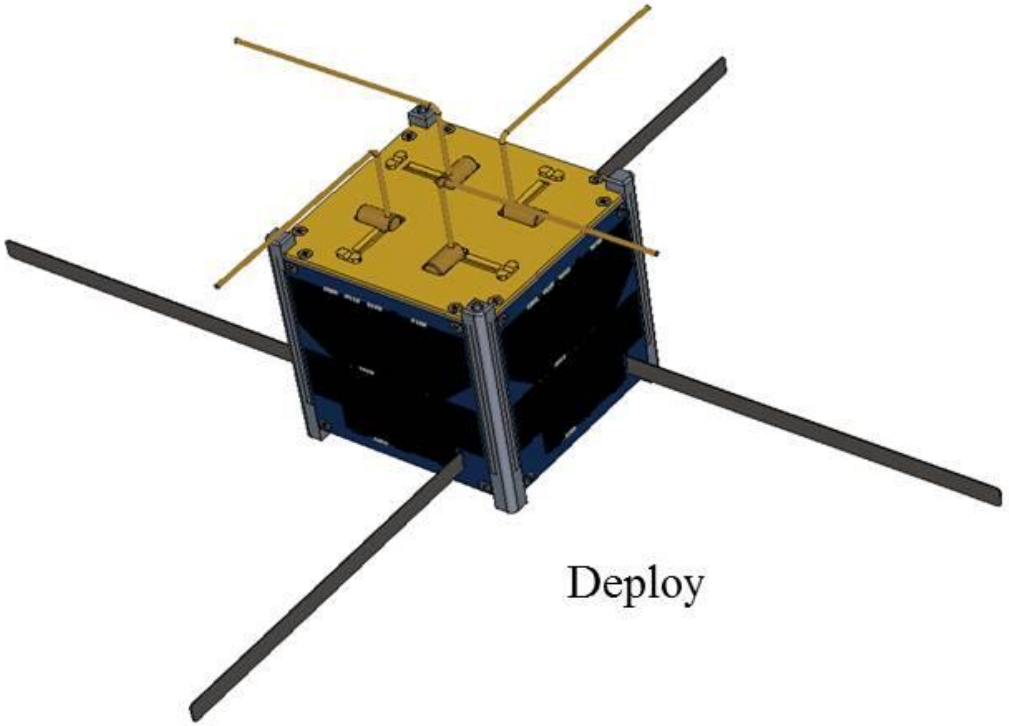
ISS Utilization: JEM/Kibo

- MYSat is plan to be released from JEM Remote Manipulator System using the JEM Small Satellite Orbital Deployer (J-SSOD).

3D View

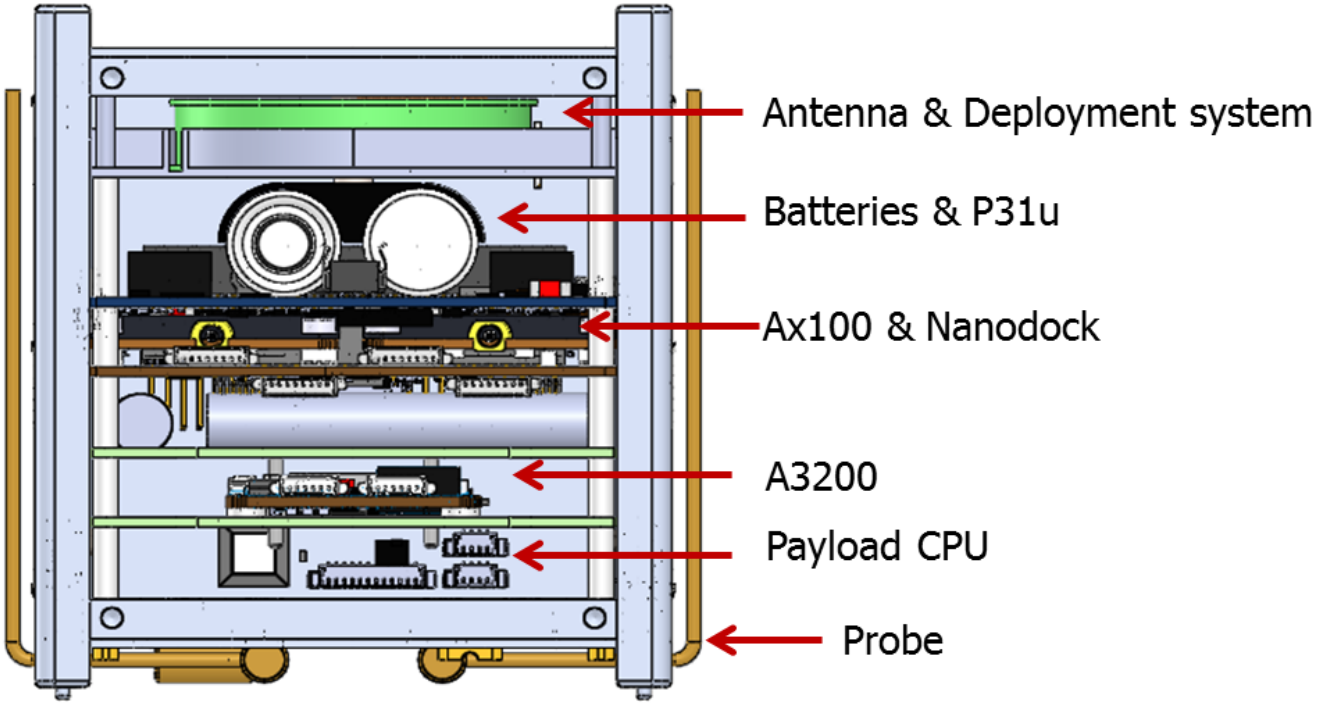
Stow





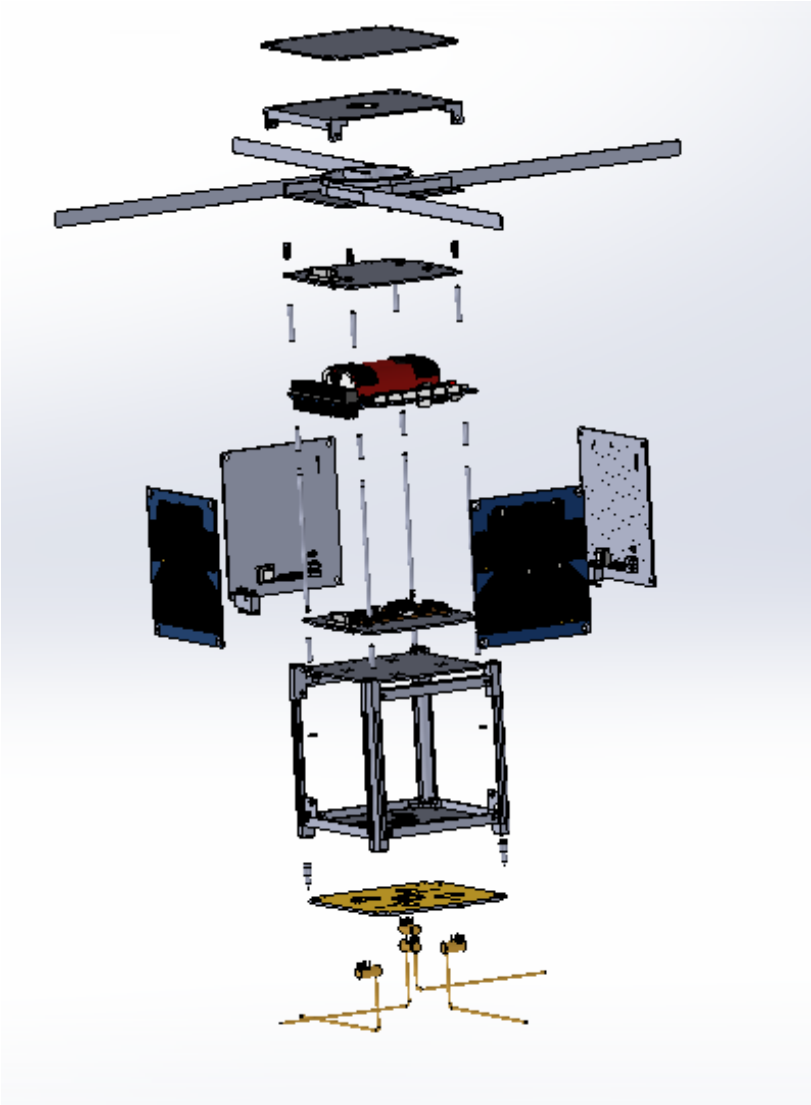
Deploy

3D View - Internal



Internal compartment

3D View – Exploded view



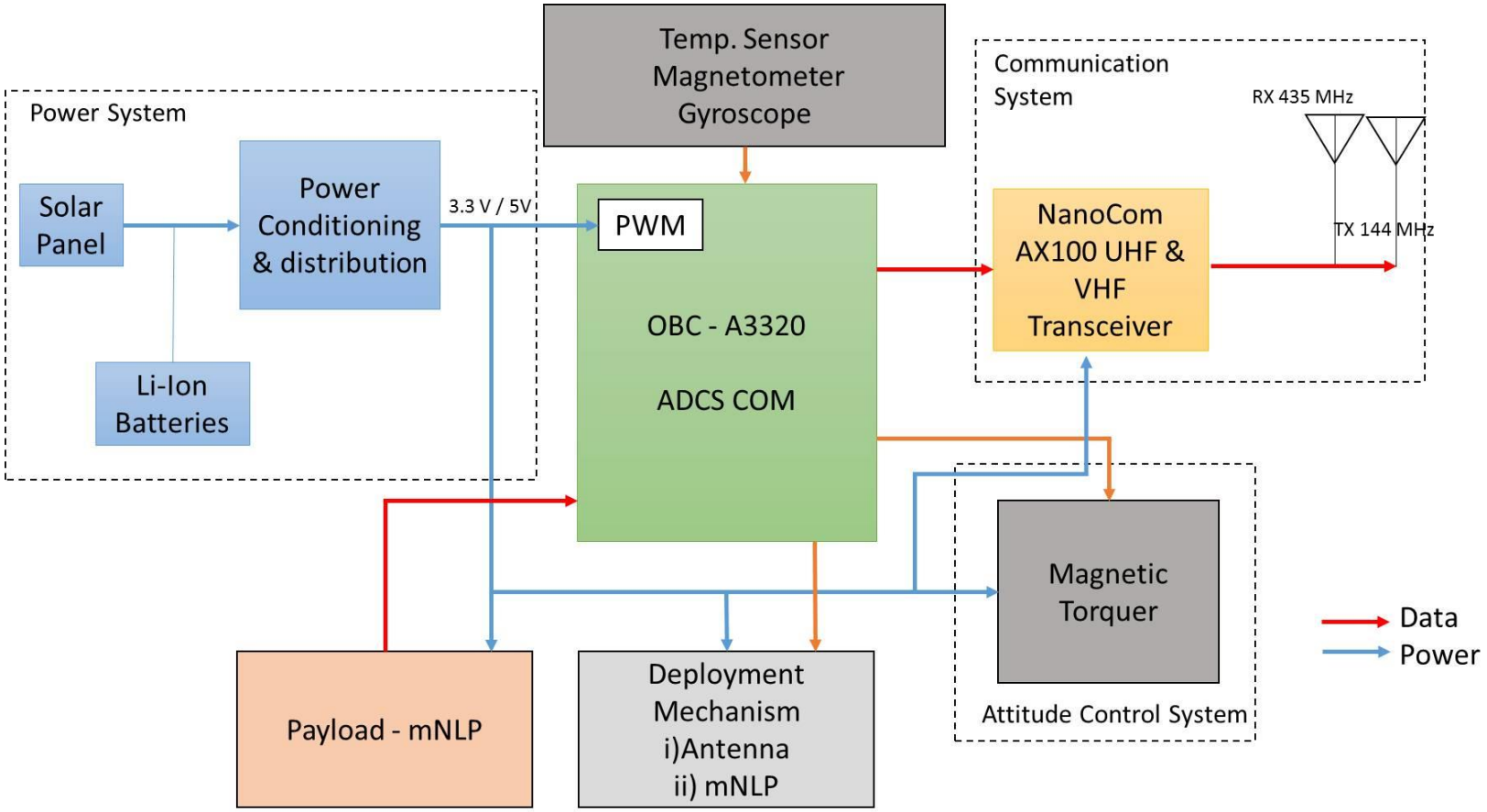
Exploded view

Mass Budget

No	Subsystem	Mass (kg)
1.	Payload	0.224
2	Power	0.304
3.	ADCS	0.060
4.	On-board Computer	0.014
5.	Communication	0.117
7.	Structure	0.200
	Total	1.015

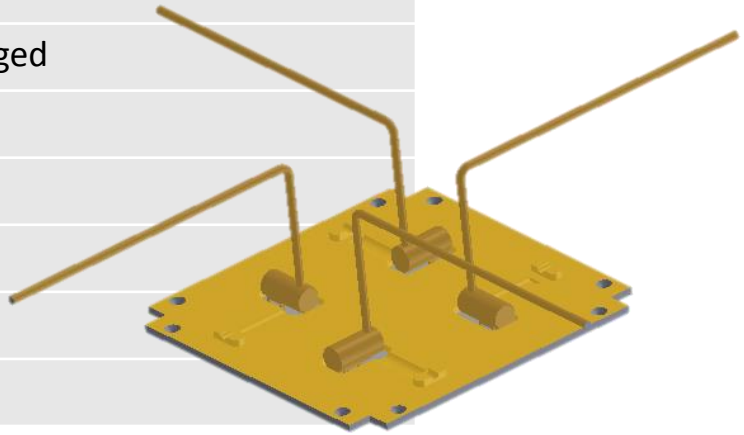
With 20% margin the mass for MYSat is 1.218 kg

System Block Diagram



Payload – multi Needle Langmuir Probe

Mass	220 g (including boom system and electron emitter)
Store temperatue	18° C to 23° C
Operational Temperature range	-20°C to 40° C
Non-operational temperature	-30° to 70° C
Minimum standby temperature	-20°
Thermal capacity	122 J/K ±20%
Radiative properties	Alpha = 0.08 epsilon = 0.15 (numbers given for Alodine 1200 surface)
Contact area	~2000 mm^2
I/F conductance	~250 W/m^2K
Thermal interface filler	Bare metal contact envisaged
Pointing accuracy for attitude control	15°
Pointing knowledge for attitude control	5°
Data rate	Not exceeding 2 Mbit/day
Nominal Science Power Consumption (W)	1.18
Duty cycling (to obtain 0.5W)	42%

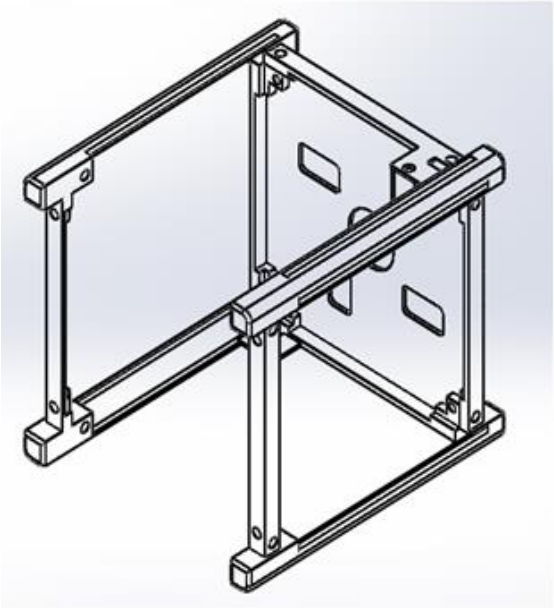


Structure

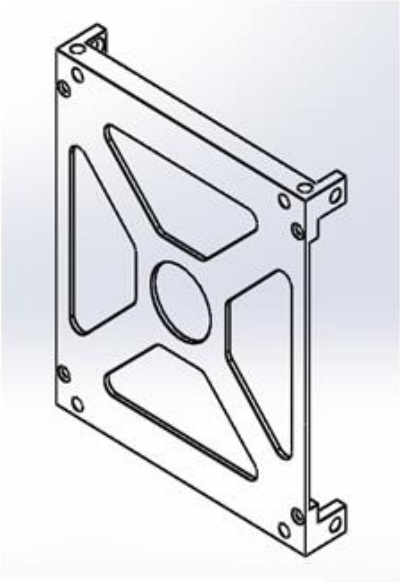
Materials

- Aluminium 6061-T6 chassis black hard anodized and blank alodyned
- Aluminium 6061-T6 shear panels blank alodined
- Stainless Steel fastener, screw and rivet
- Stainless steel threaded rod
- Stainless steel spacer
- Aluminium Antenna casing

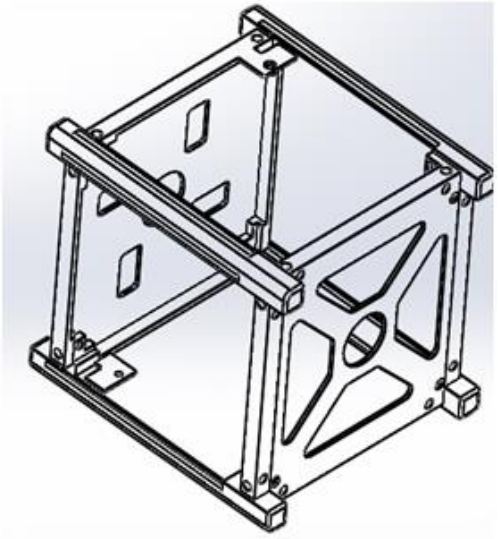
Structure – Frame



Main Frame

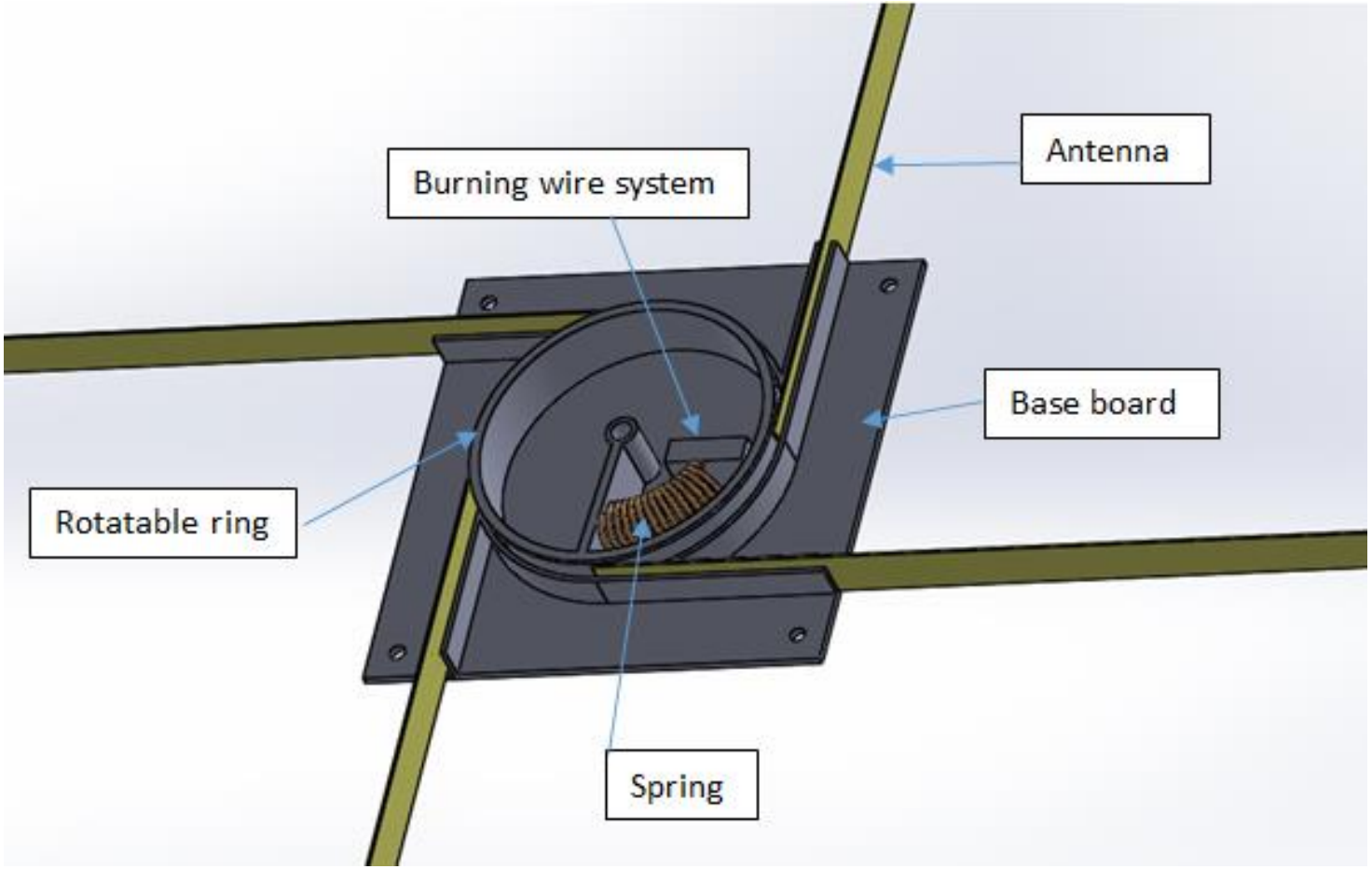


Top Frame



Assembly

Structure – Separation mechanism



Antenna Deployment System

Power Subsystem

Component	Max Power (mW)	Orbit ON %	Time On (s)	Avg. Power (mW)
OBDH				
A3200	132	100	5561.4	132
Power				
Nano Power P31u	115	100	5561.4	115
Main Communication				
NanoDock	16.5	100	5561.4	16.5
AX100 Tx UHF	2805	9	500.526	252.45
AX100 Rx VHF	396	9	500.526	181.5
RxStandby Mode	149	81	5561.4	120.69
Payload				
mNLP	560	100	5561.4	560
ADCS				
Magnetometer	3	100	5561.4	3
Gyroscope	12	100	5561.4	12
Magnetorquers	250	100	5561.4	250
TOTAL	3893.5			1643.14
20% Margin				**1971.768**

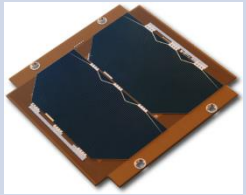
On-Orbit Average

Power Subsystem

The power system mainly consists of :

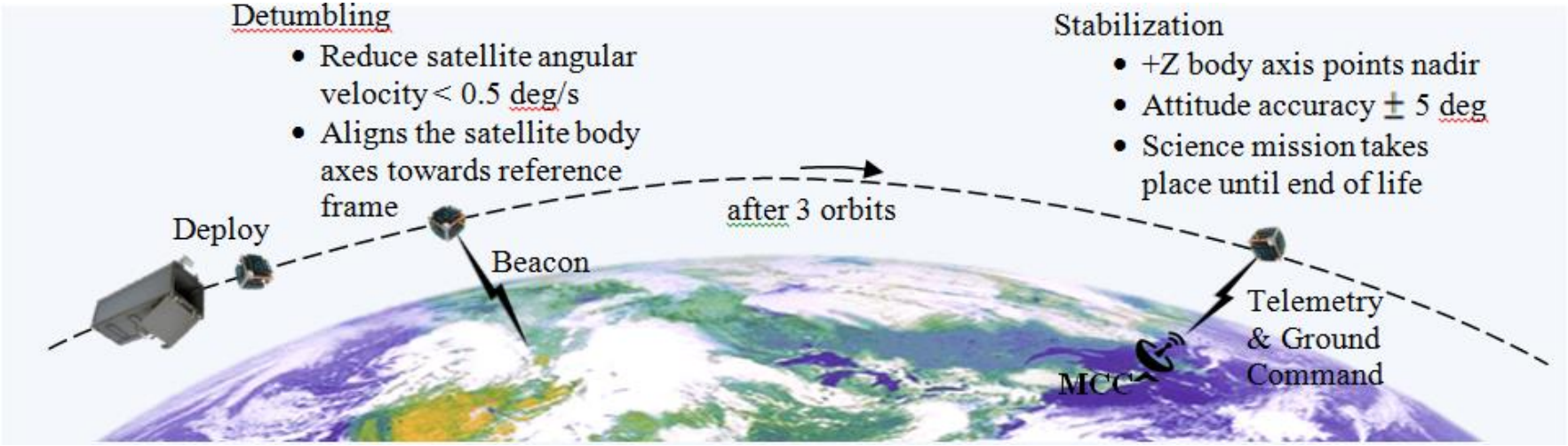
- **Photovoltaic cells**
- **Photovoltaic power converters**
- **Batteries**
- **Battery protective circuit board**

Power Subsystem

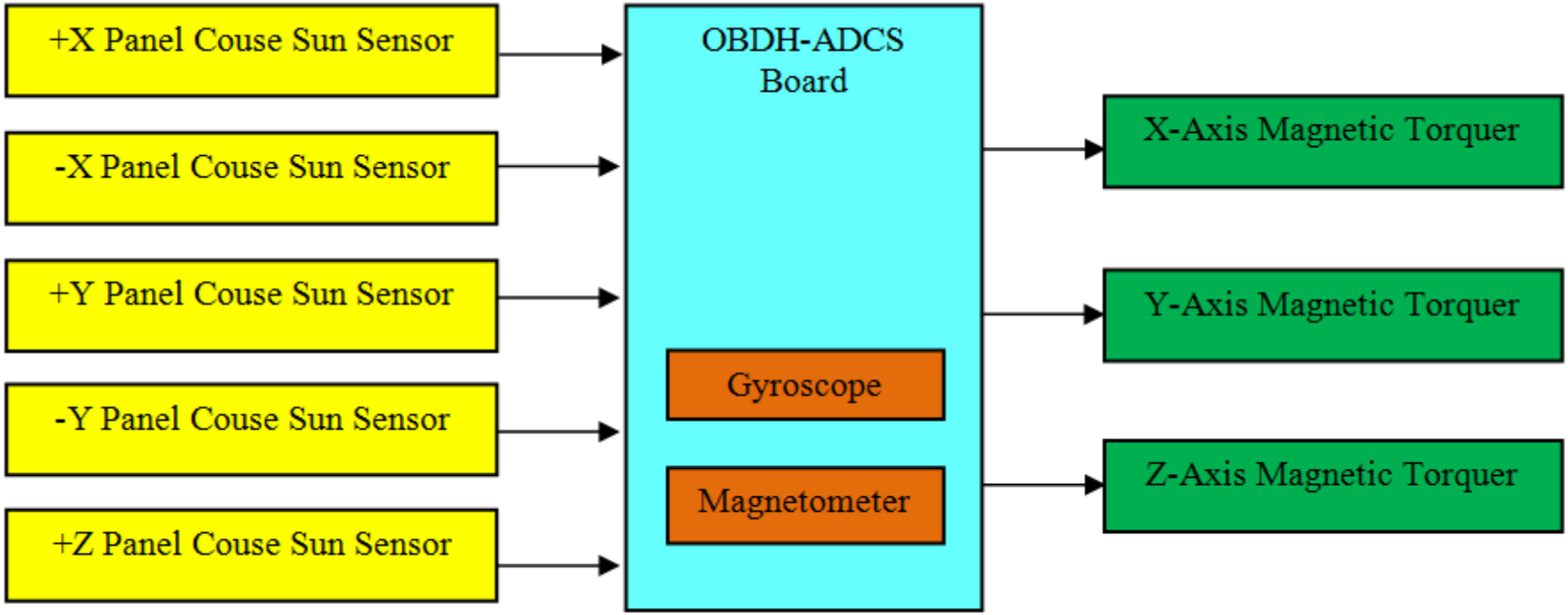
No.	Name	Specification	Quantity	Total Weight (g)	Power Consumption (mW)	Power Output (mW)
1.	Photovoltaic Cell 	NanoPower P110 • Module Weight: 26 g • Power Output: 2400 mW • Efficiency: 30% • Effective cell area: 60.36 cm^2 • Size: 98 X 83 X 5 mm	4	104	0	9600
2	Battery w/ Power Management System 	NanoPower P31u + Nano Power Battery • Battery Thermal Regulator • Photovoltaic Power Converter • Battery Charge Discharge Regulator • Lithium Ion 18650 • 2S-2P Configuration • Voltage: 7.4 V • Current: 5600m Ah • Size: 96 X 90 X 26 mm	1	270	115	7400

ADCS

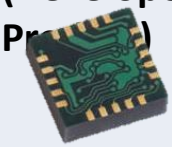
- **Active magnetic control technique to detumble and provided 3-axis stabilization to the satellite.**
- **Provide maximum magnetic control torque of about 1.5 x 10^{-6} Nm to detumble the satellite within 3 orbits and stabilize it with 5 deg attitude accuracy.**
- **The satellite has no orbit control system since it has no orbit correction operation.**



ADCS – Functional diagram



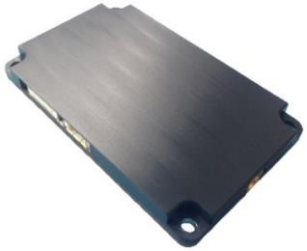
ADCS

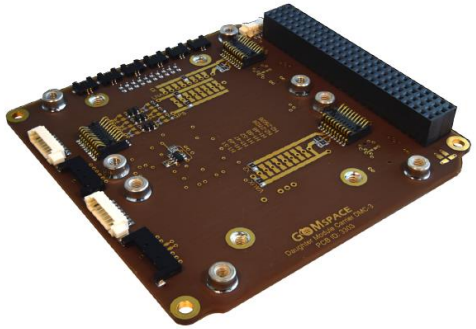
Sensor/Actuator (Number Needed)	Manufacturer (Model)	Total Mass	Power Requirement	Operating Temperature
Sun Sensor (6) (Developed Pr[illegible]) 	Silonex Inc (SLSD-71N3)	To be determine (TBD)	None	-40 °C to 105 °C
3-Axis Magnetometer (1) (Developed Pr[illegible]) 	Honeywell (HMC5843)	0.05 g	59.4 mW	-30 °C to 85 °C
3-Axis Gyroscope (1) (D[illegible]ped Pro[illegible]) 	InvenSense (MPU-3300)	To be determine (TBD)	12 mW	-45 °C to 105 °C

ADCS

Sensor/Actuator (Number Needed)	Manufacturer (Model)	Total Mass	Power Requirement	Operating Temperature
ADCS Microcontroller (1) (Developed Product) 	GomSpace (NanoMind A3200)	14 g	132 mW	-30 °C to 85 °C
Magnetic Torquer Rod (3) (To be developed) 	In-house produced component	60 g	250 mW	-60 °C to 100 °C

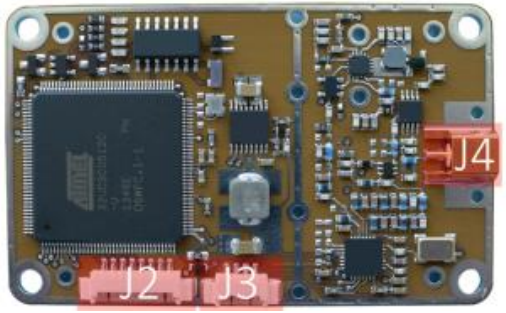
Communication

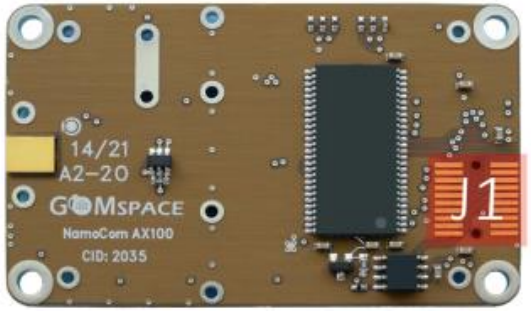




- **Transceiver (NanoCom : AX100U)**
- **Nanodock DMC-3**
- **Antenna - Steel**

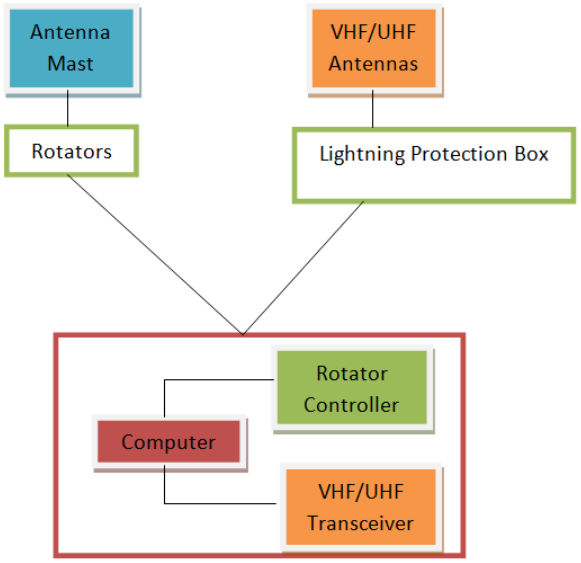
Downlink: UHF 430-440 MHz
Uplink : VHF 140 MHz

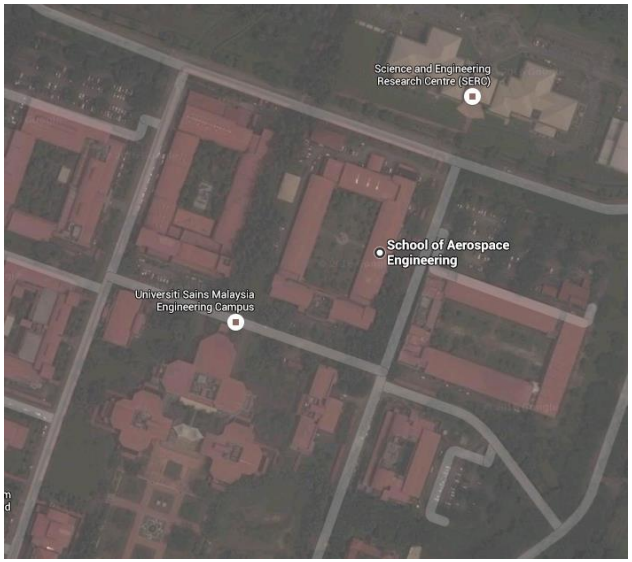




Ground Station

- The new ground station will be developed for the satellite mission.
- Currently, the location will be at Space System Laboratory, Universiti Sains Malaysia.
- Generally, the ground station comprises of two main components according to the location: an outdoor part; antenna and rotators and an indoor part; computer, rotator controller, vhf/uhf transceiver and most of the electronic systems.

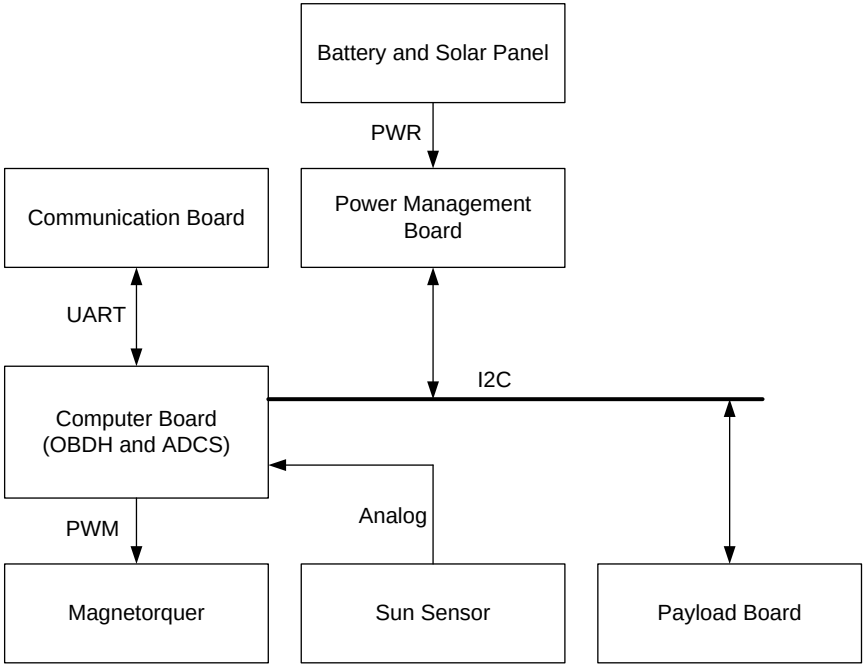




OBDH

- The On-Board & Data Handling (OBDH) that is Nanomind A3200 from GOMspace is selected due to it reputability as flight proven component.
- The future planning is to develop the on-board computer in-house.

Nanomind A3200



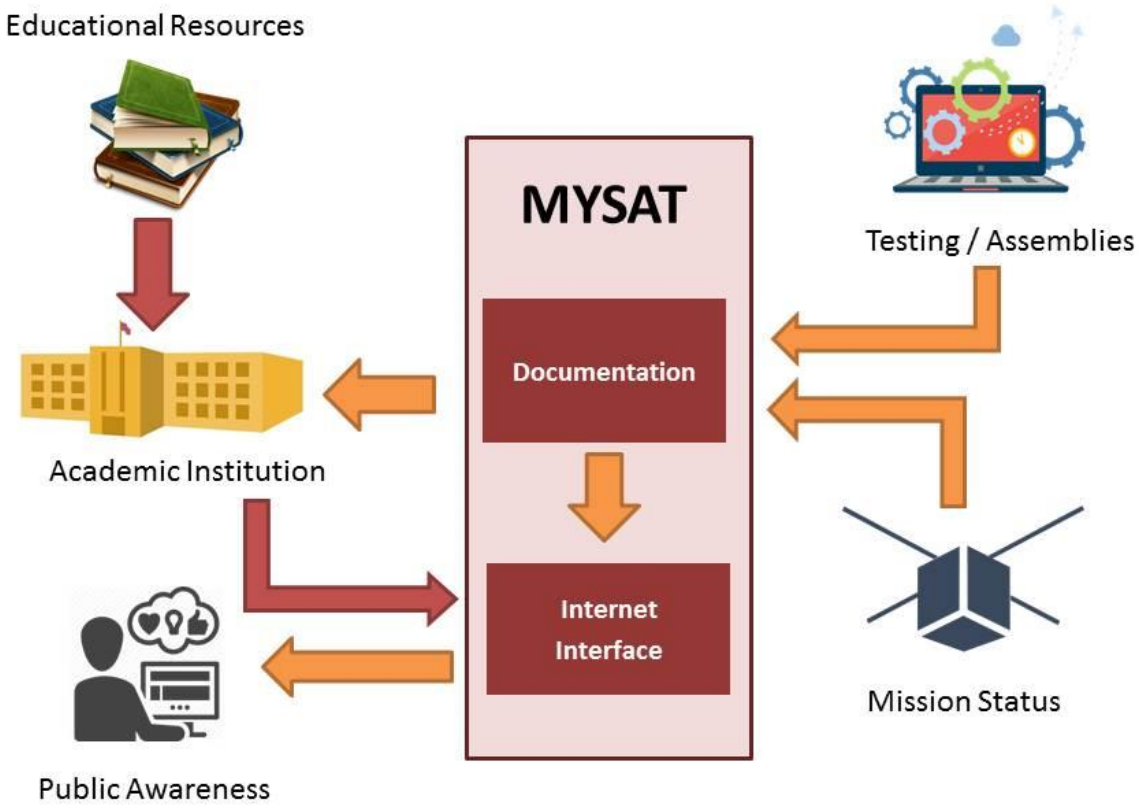
OBC System Block Diagram

Components

No	Component	In-house Produced (Developed)	Purchased (Developed)	Purchased (Proven)
1	CubeSat Structure	X		
2	Deployment Mechanism	X		
3	Solar Panel			X
4	Batteries			X
5	Power regulator board			X
6	On-board Computer			X
7	Magnetic Torquer			X
8	Sun sensor			X
9	Gyroscope			X
10	Magnetometer			X
11	Transceiver			X
12	Antenna	X		
13	Ground station antenna	X		
14	Ground station equipment			X
15	Payload - Langmuir Probe		X	

Outreach / Capacity Building

Information Flow

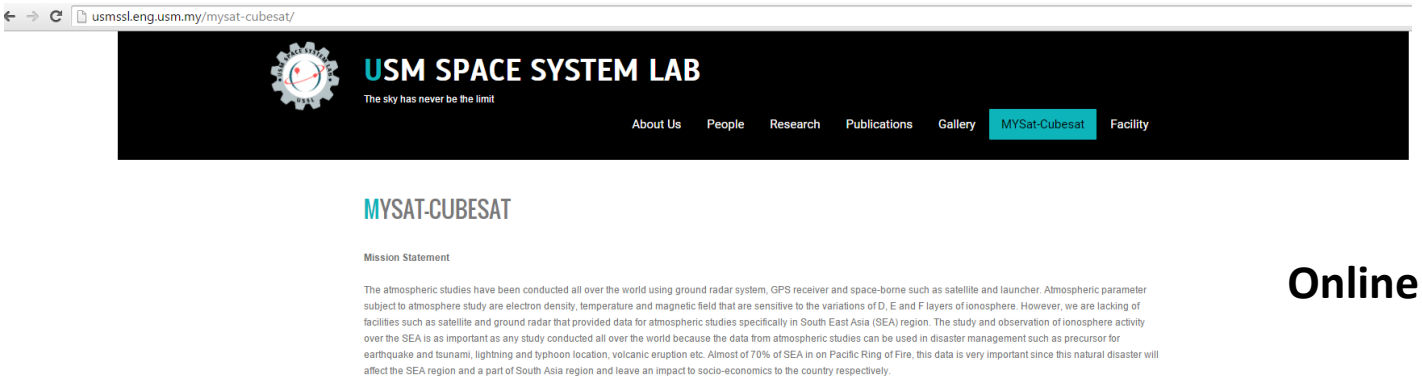


Flow chart for MYSat documentations and space outreach program

Outreach Program

Knowledge-based educational outreach

Social Media



Online

Current Status

- **Detail studies**
- **Main structure development – structure analysis , prototype for deployment mechanism**
- **Fund**
- **Outreach**

Thank You