NOORUL ISLAM CENTRE FOR HIGHER EDUCATION
(NOORUL ISLAM UNIVERSITY)

GENERIC NANO-SATELLITE FOR MONITORING FLOODS, LANDSLIDES AND FOREST FIRES
(CONCEPT PAPER PROPOSAL)

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NIUSAT STUDENT NANOSATELLITE IS UNIQUE?

ALL SUB-SYSTEMS ARE HAVING REDUNDANTANCY

Why NIUSAT is a Generic Satellite . . .

- NIUSAT is configured as bus module and payload module
- The bus module can support any payload with size <300x300x150mm and power requirement of about 10 to 15watts
- Flexible attitude control accuracy from 0.5 deg to <10 arc sec
- Fully redundant for all the bus systems(Power, TTC, AOCS & RF systems)
- Functionally co-located systems (Solar panel, Battery, & Power Electronics in single panel)
- Provision for PPT/any other thrusters for orbit maintenance and deorbiting
- Use of Cube sat standard modules for all subsystems
- Fully accessible to any of the subsystems for any problems

PROPOSED CONCEPT

- Realization of suitable nano sensors for monitoring of the disasters like

  Floods

  Landslides

  Forest fire (SWIR)

  Constellation (SAR Camera Resolution:<20m)

- Selection of suitable spectral bands and spatial resolution
- Generic Nano satellite configuration
- Nano satellite constellation for global coverage
- Summary of Constellation options
- Possible collaborations

PROPOSED SPECTRAL BANDS AND POSSIBLE APPLICATIONS

Band	Spectral definition	Possible applications
Visual Blue	420-510 nm	Provides the best data for mapping depth-detail of water-covered areas. It is also used for soil-vegetation discrimination and forest mapping.
Visual Green	490-590 nm	The blue-green region of the spectrum corresponds to the chlorophyll absorption of healthy vegetation and is useful for mapping detail such as depth or sediment in water bodies.
Visual Red	580-670 nm	Chlorophyll absorbs these wavelengths in healthy vegetation. Hence, this band is useful for distinguishing plant species.
SWIR	1550-1700 nm	Forest fire detection. This region is also sensitive to plant water content, which is a useful measure in studies of vegetation health. This band is also used for distinguishing clouds, snow, and ice.

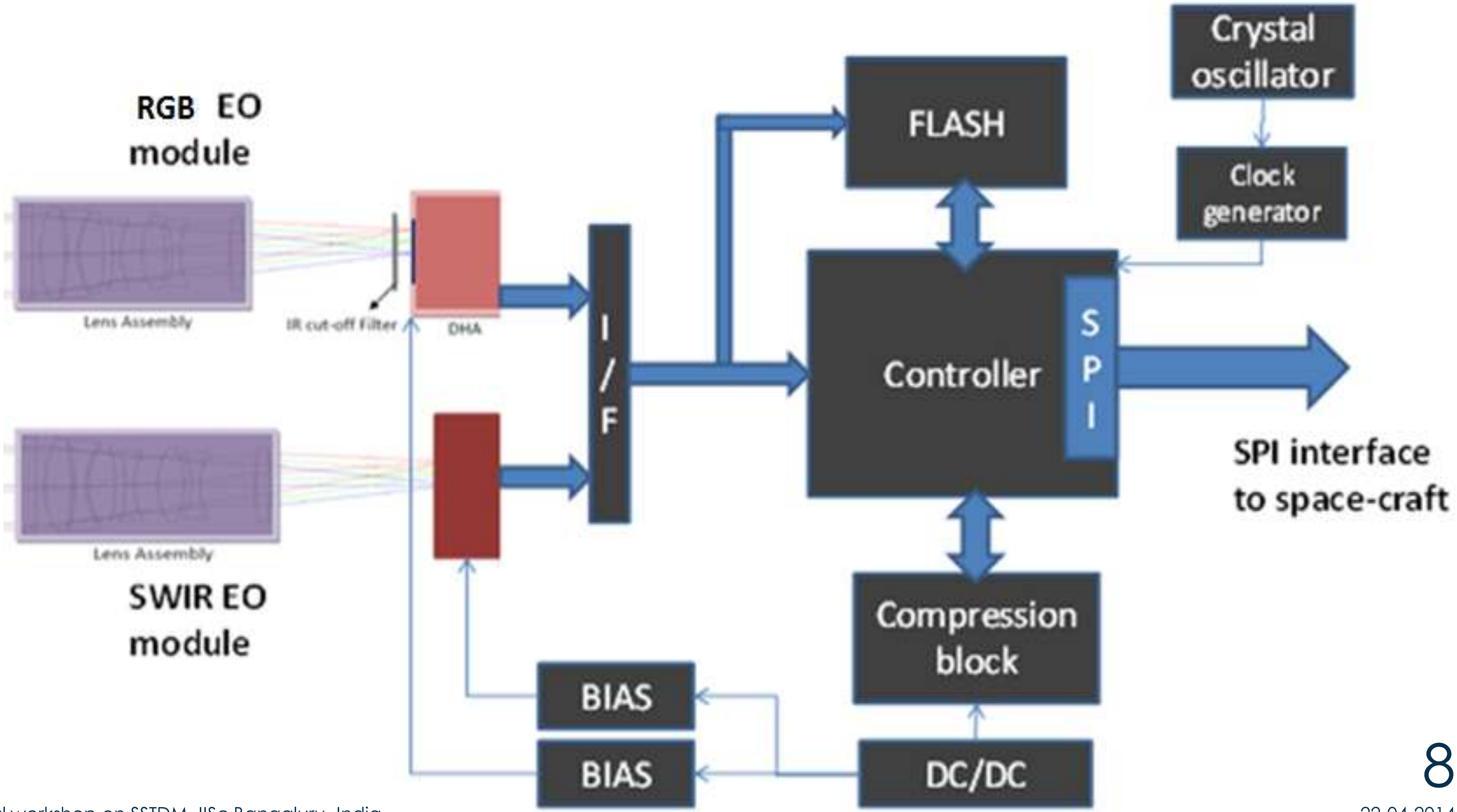
PROPOSED RGB CAMERA

Sr No	PARAMETER	Values
1	Ground sample distance (GSD) (m)	30
2	Coverage area (Km)	61.4 x 61.4
3	Spectral band (µm)	B(0.42—0.51), G (0.49-0.59) & R (0.58-0.67)
4	Saturation Radiance (mW/cm2-sr-µm)	B: 53; G: 53; R: 47
5	Integration time (µs)	130
6	Quantization (bits)	8
7	SNR at saturation	> 100
8	Operating freq (MHz)	100
9	Altitude	600
10	Pixel size (µm)	5.5
11	Frame (pixels)	2048 x 2048
12	Effective focal length (mm)	110
13	F/#	4
14	Field of view (°)	8.4

PROPOSED SWIR CAMERA

Sr No	PARAMETER	Values
1	Ground sample distance (GSD) (m)	120
2	Coverage area (Km)	76.8 x 61.4
3	Spectral band (µm)	1.55-1.7
4	Saturation Radiance (mW/cm2-sr-µm)	7.5
5	Integration time (µs)	140
6	Quantization (bits)	8
7	SNR at saturation	> 150
8	Altitude	600
9	Pixel size (µm)	25
10	Frame (pixels)	640x512
11	Effective focal length (mm)	125
12	F/#	4
13	Field of view (°)	9.4

BASIC BLOCK DIAGRAM OF NIUSAT CAMERA



FEATURES OF NIUSAT NANO SATELLITE

Structure/Thermal/Mechanism

- Overall size:274 x 274 x 195mm3
- Mass: < 15 kg
- Structure mass: 3.8 kg
- Solar Panel Deployment Mechanism
- Antenna Deployment Mechanism
- Passive and Active Thermal Control System

Communication System

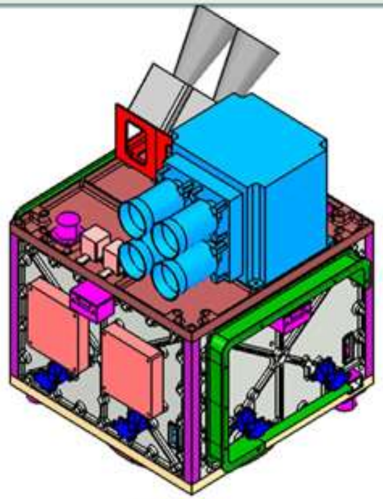
- ❖ HKTM data transmitter in UHF (420- 450 MHz) band
- ❖ Tele-Command receiver in VHF (144-148 MHz) band
- ❖ Payload data transmission in S- band (2240MHz).
- ❖ monopole Antenna for UHF/VHF for data transmission & reception
- ❖ High gain patch antenna for S-band transmitter

Power

- ❖ Total Power Generation : ~40 W
- Battery Capacity (2 nos.) : 5AH
- Multi Junction Solar Cells based Solar Array
- Stowed during launch and deployed in Orbit
- MPPT based Battery Charge Regulator

Payload

- WIDEFIELD SENSOR (4 band)
- Resolution : 35m at 600km altitude
- Swath : 140 km
- Quantisation : 12 bit
- Input Data Rate: 28 Mbps
- Data Compression : JPEG 2000
- Output Data Rate : 1 Mbps



On Board Computer

- High performance dual core 32 bit E200 Power Architecture
- 2 MB Code flash memory with ECC
- 32 GB storage flash for payload data storage
- Supports I^2C, CAN and UART ports
- Supports software tunes and WDT

Mission

- Polar Sun Synchronous Orbit
- Orbit altitude : 560 – 880 km
- Orbital inclination : 97°-99°
- Orbital Period : 96-100 min
- Repetivity/ Revisit : Everyday
- Visibility : 4 orbits per day

AOCS

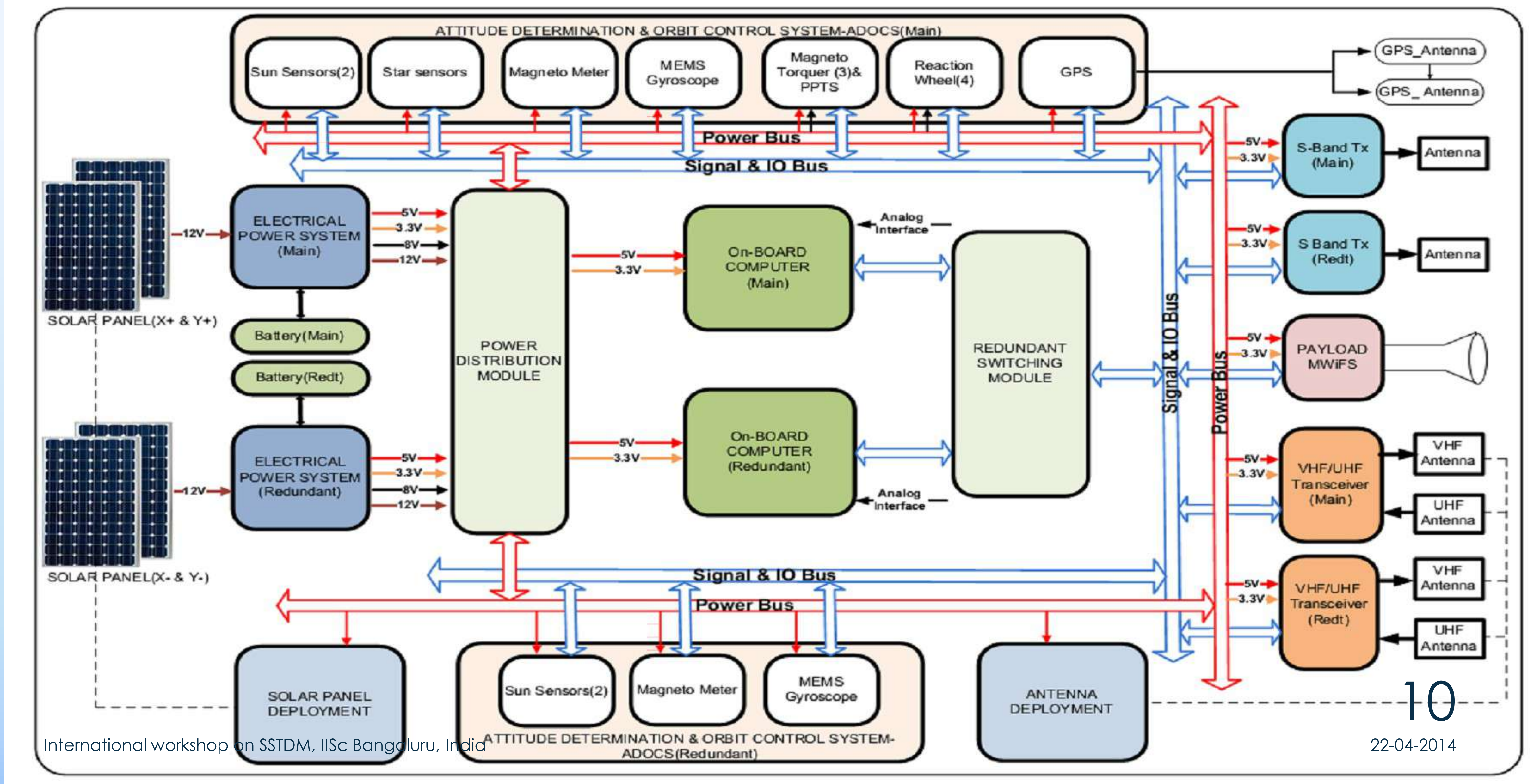
3 axis attitude Stabilized configuration

- Sun sensors, Magnetometers and MEMS Gyroscopes
- Magnetic Torquer and 4 Nos of Micro Reaction Wheel
- Control Algorithm residing in OBC
- STAR SENSOR and PPT provision kept for fine pointing and orbit correction

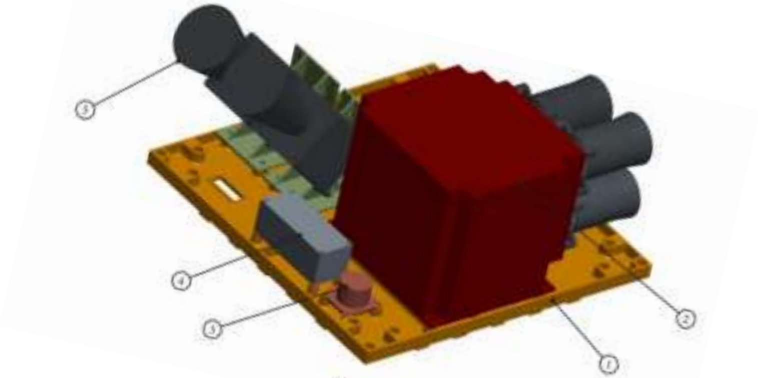
Ground Station

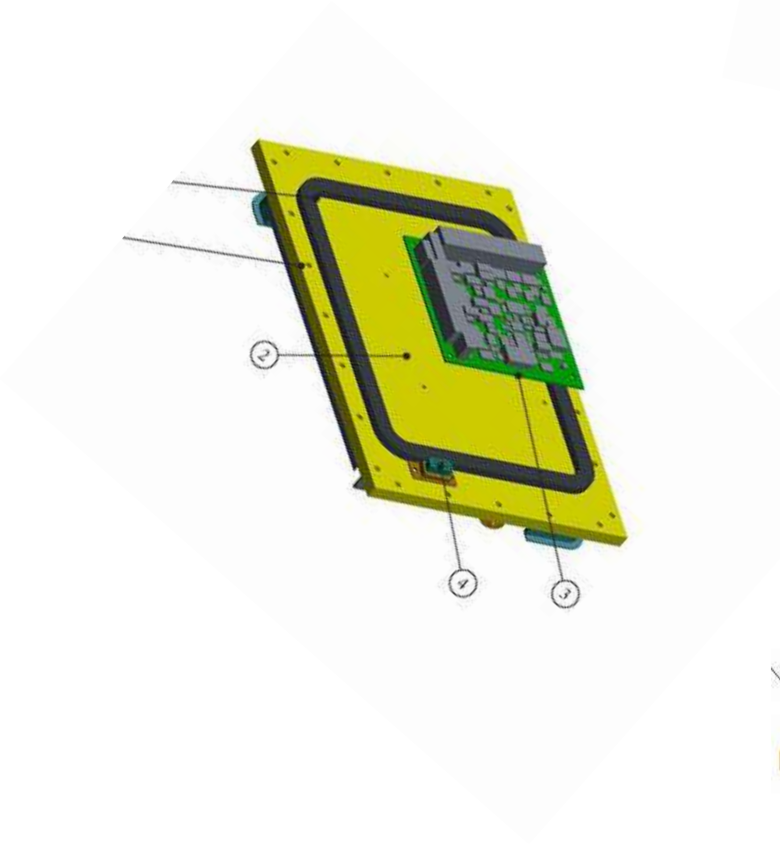
- UHF Downlink and VHF Uplink antennae
- 3 meter reflector S-band antenna for payload data reception
- Mission Control Centre
- Payload Data Processing Centre
- Auto tracking Using TLE/ OD Data

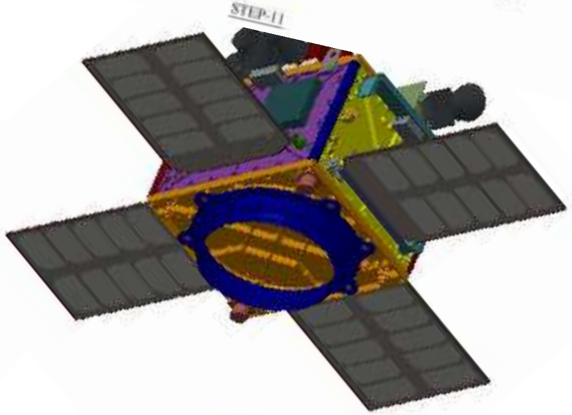
FUNCTIONAL BLOCK DIAGRAM OF NIUSAT

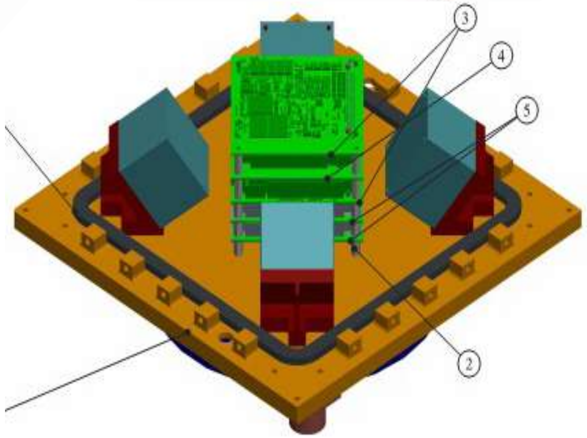


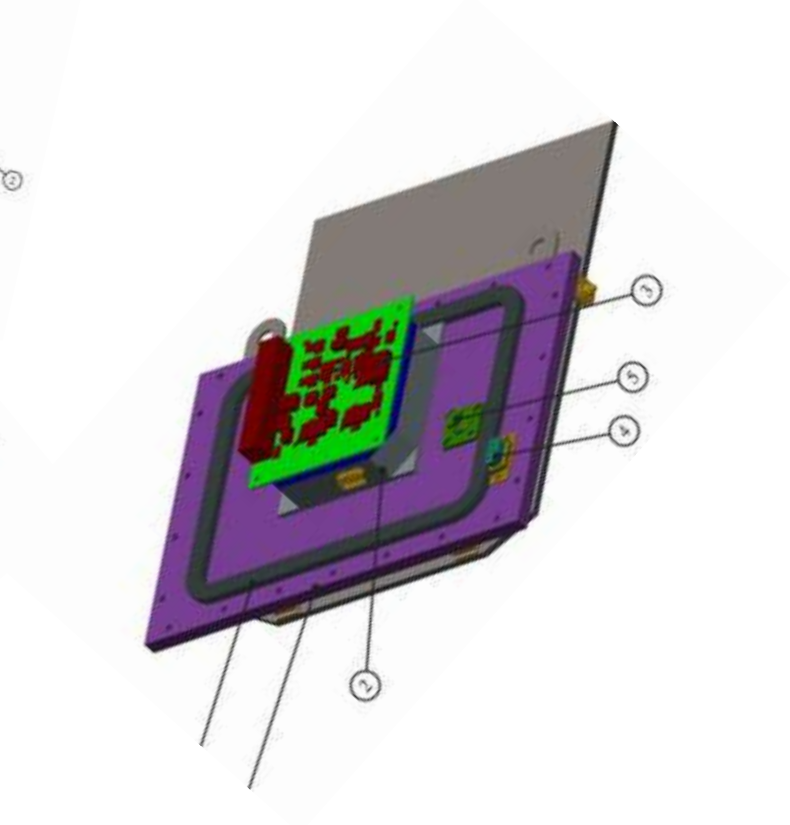
STRUCTURAL LAYOUT OF NIUSAT WITH MULTISPECTRAL CAMERA



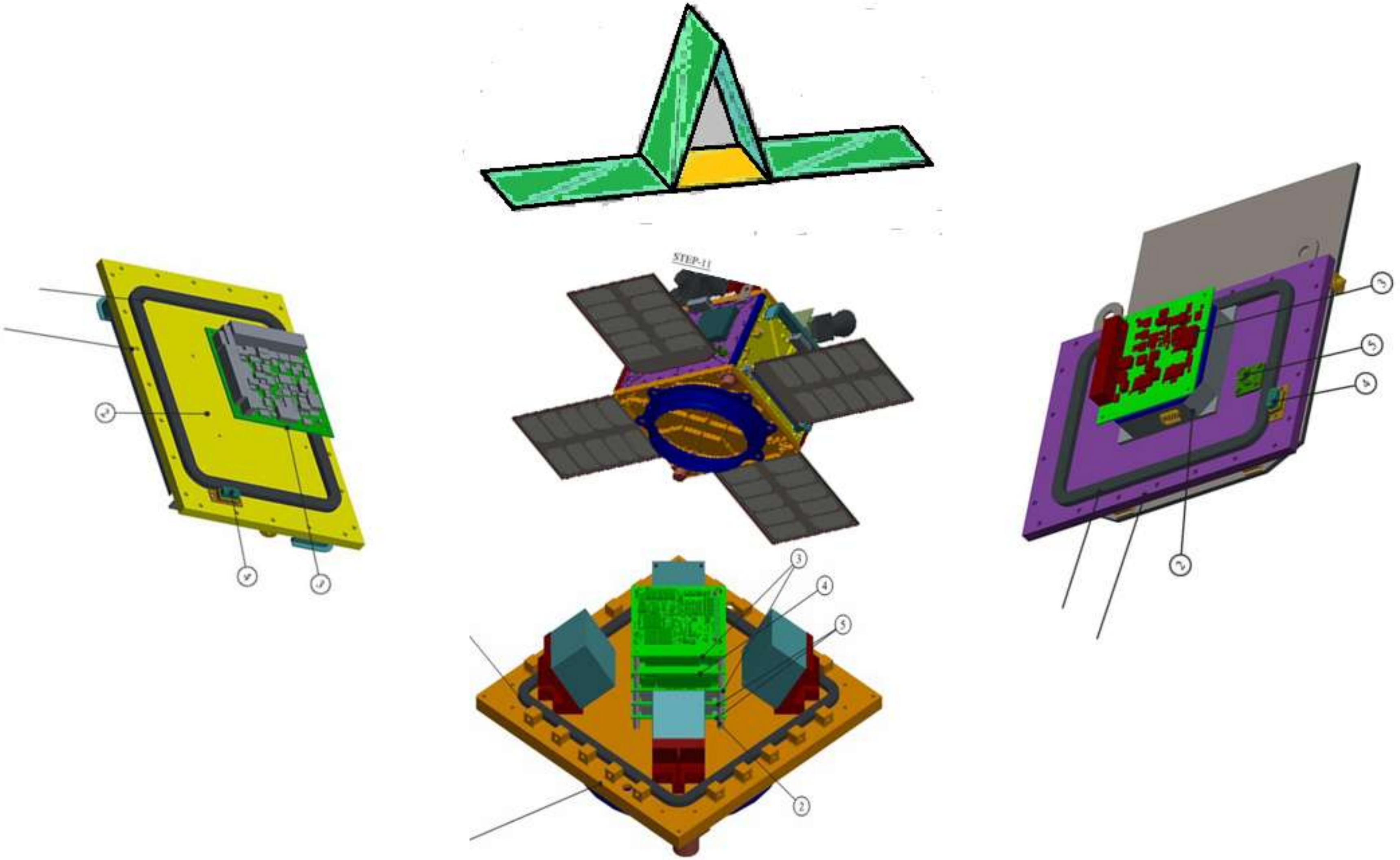




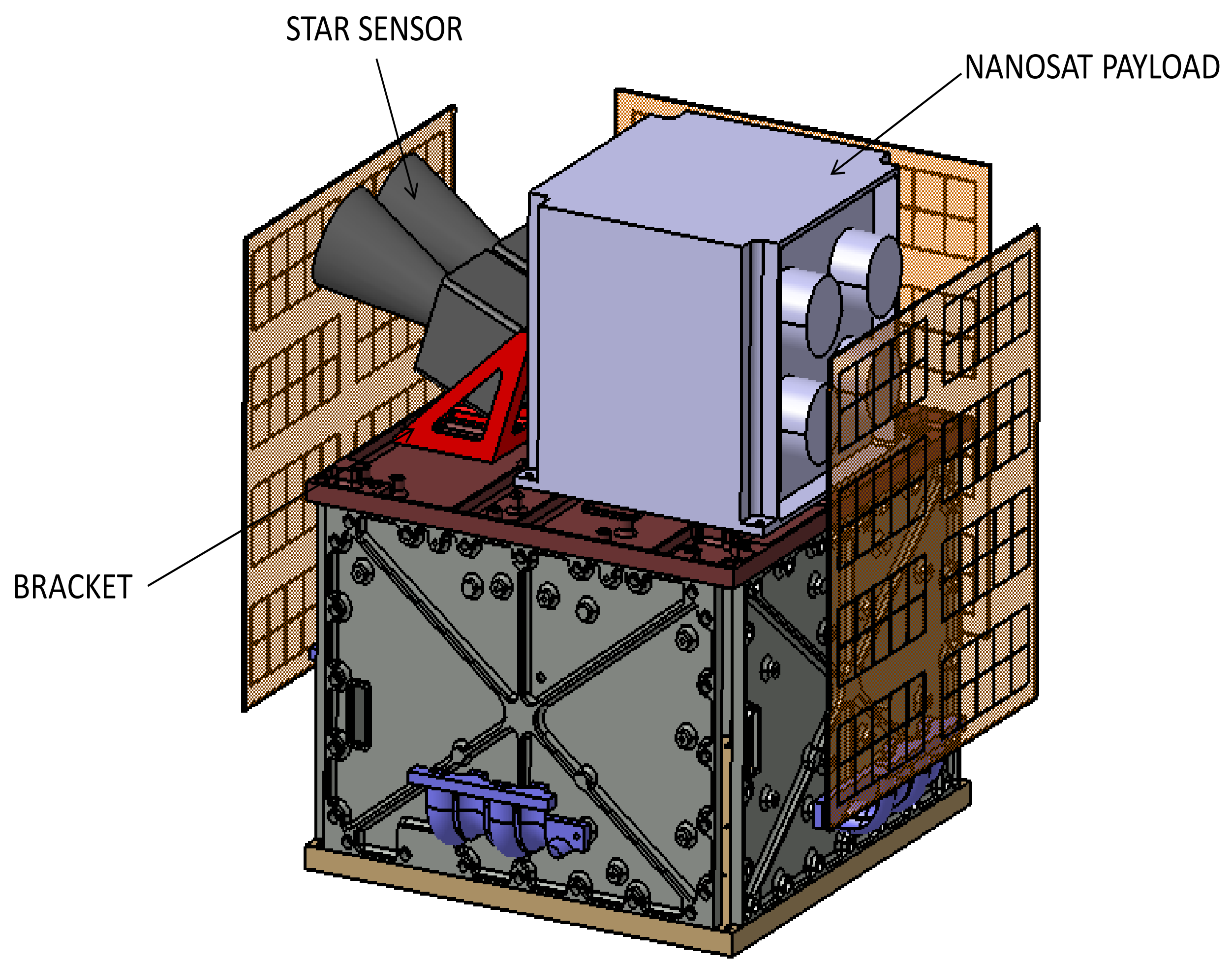




STRUCTURAL LAYOUT OF NIUSAT



NIUSAT WITH MULTISPECTRAL CAMERA MOUNTED ON TOP DECK



S-BAND, UHF/VHF ANTENNA AT NIU

Sensors and Constellation options

Proposed sensor options for the constellation

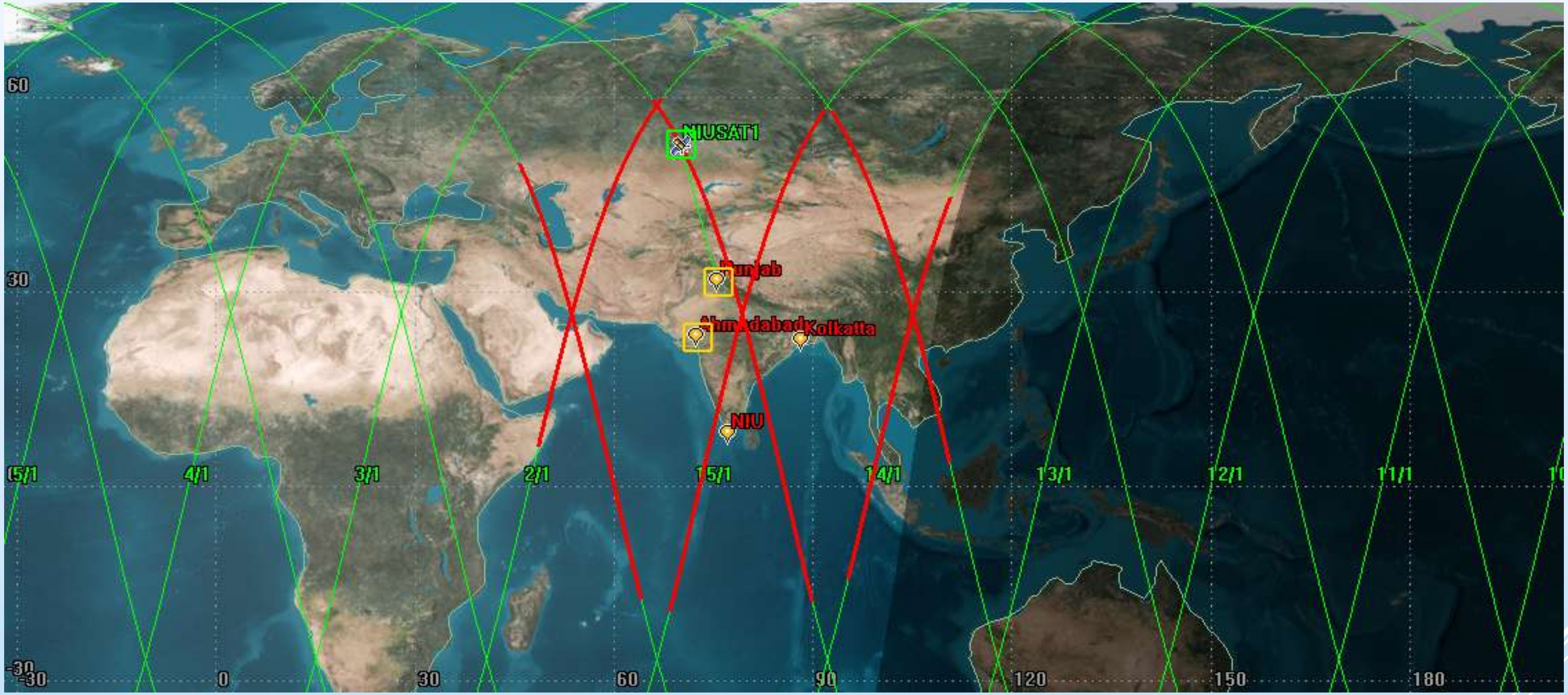
- **2 medium resolution (30m,4bands) optical imaging satellite**
- **1 high resolution (5m) optical imaging satellite**
- **1 SAR (10-20m resolution) imaging satellite**

Constellation options

- **4 satellites in a single plane (24 passes per day)**

PROPOSED NANO SATELLITE CONSTELLATIONS

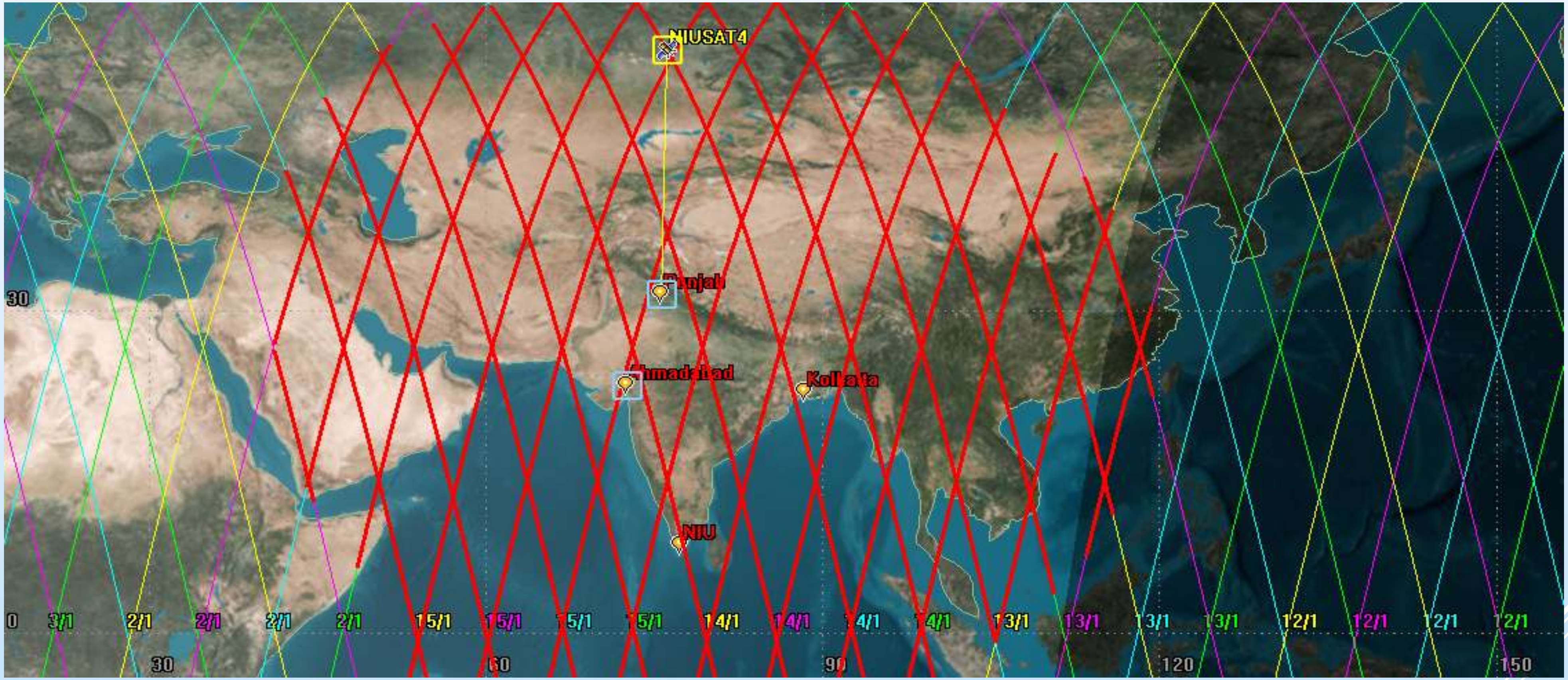
Ground Trace of One Satellite (24 hrs)



No. of contacts with ground station in one day: 6 passes

Duration of Access time with ground station: 60mins

Ground Trace of 4 Satellites in Single Plane (24 hrs)

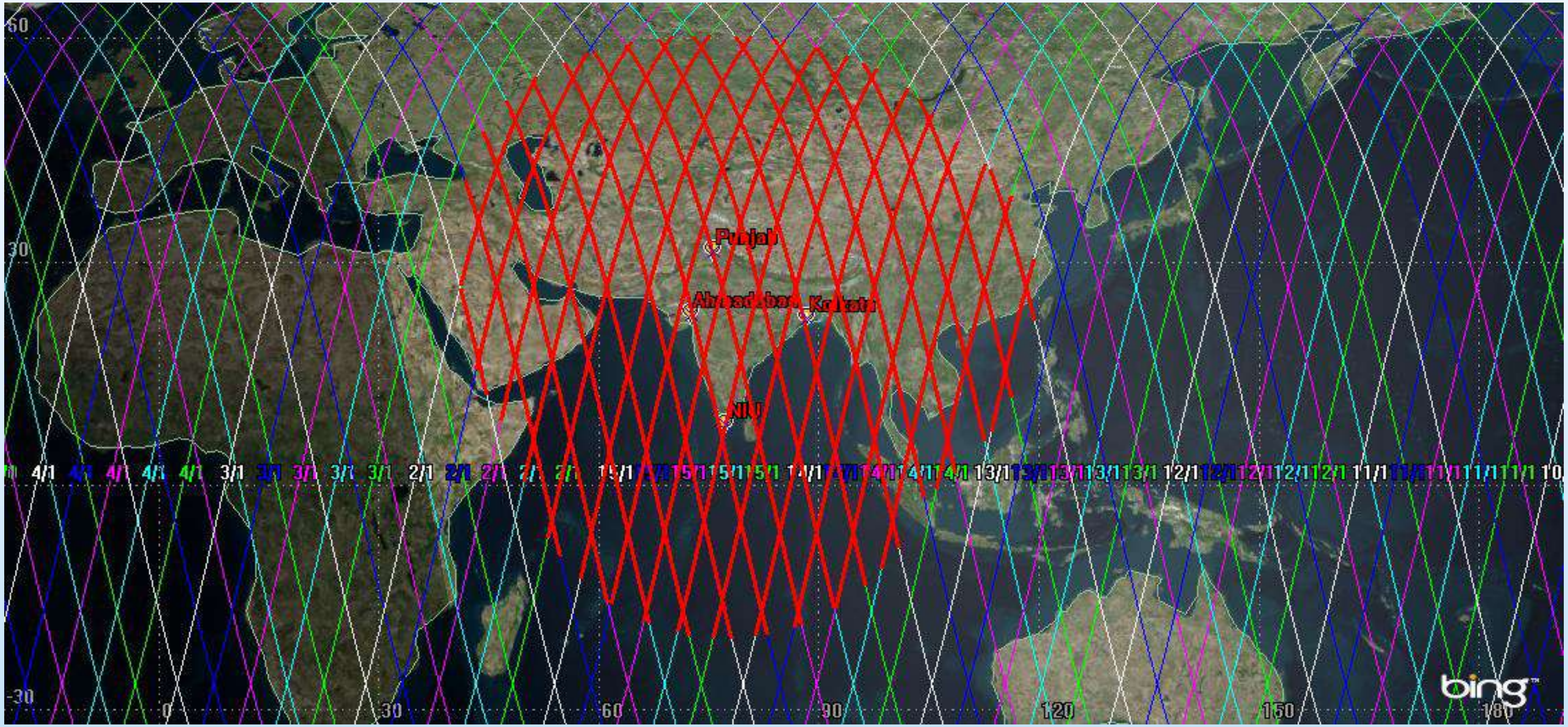


No. of contacts with ground station in one day: 24 passes (4No.of satellitex6pass)

Duration of Access of 1 satellite with ground station: 60mins

Total Access time of 4 satellites with ground station: 240mins

Ground Trace of 5 Satellites in Single Plane (24 hrs)



No. of contacts with ground station in one day: 30 passes (5No.of satellitex6pass)

Duration of Access of 1 satellite with ground station: 60mins

Total Access time of 5 satellites with ground station: 300mins (4.5hrs)

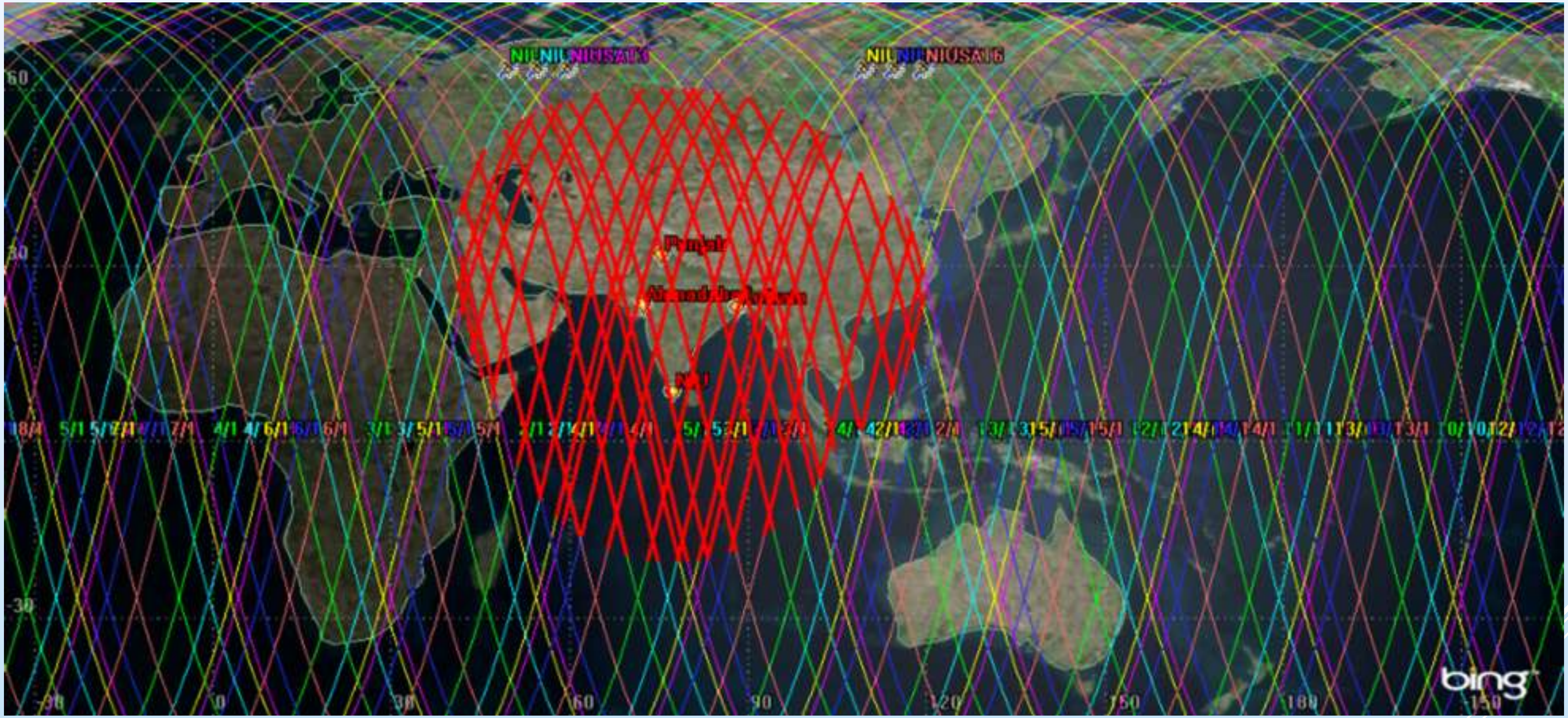
Ground Trace of 10 Satellites in Single Plane (24 hrs)

No. of contacts with ground station in one day: 60 passes (10No.of satellitex6pass)

Duration of Access of 1 satellite with ground station: 60mins

Total Access time of 10 satellites with ground station: 593.8mins (9.8hrs)

Ground Trace of 6 Satellites in Two Planes (24 hrs)

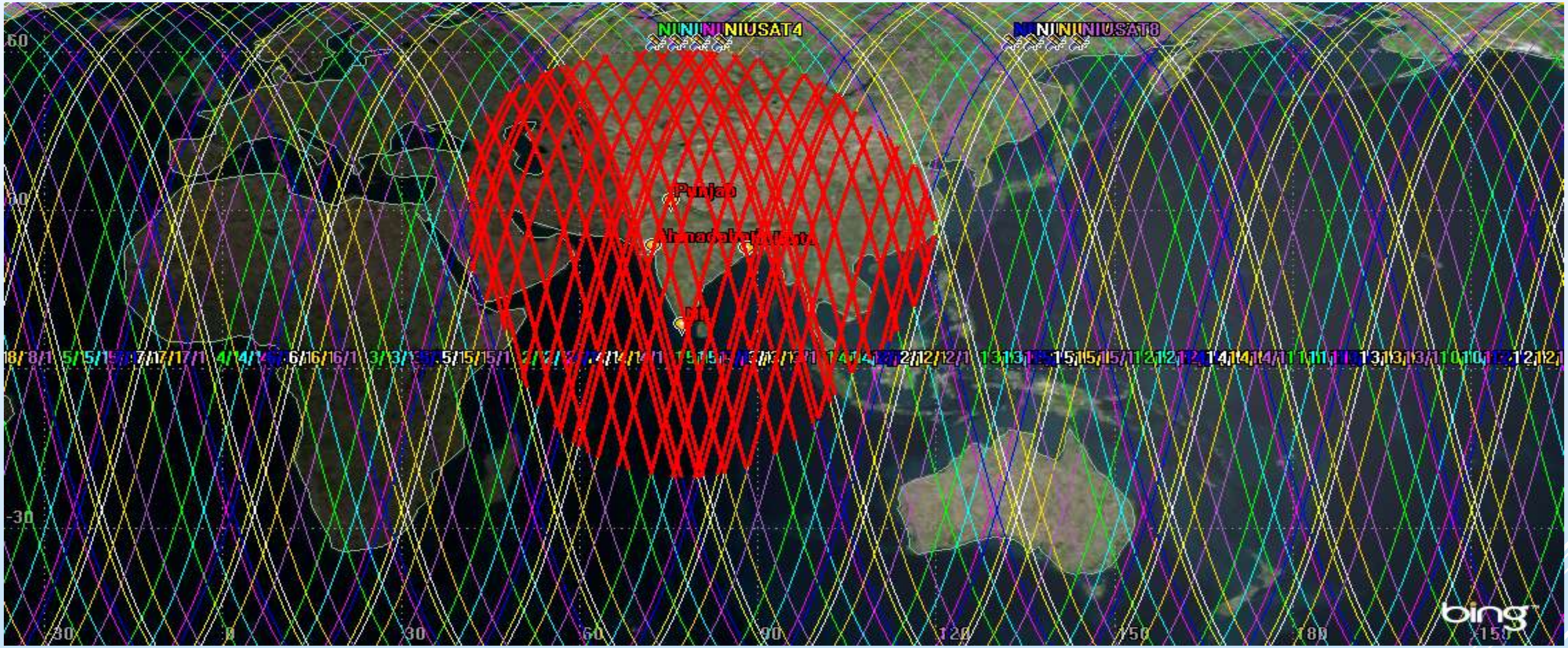


No. of contacts with ground station in one day: 36 passes (18AM & 18PM)

Duration of Access of 1 satellite with ground station: 60.12mins

Total Access time of 6 satellites with ground station: 360.72mins (6.012hrs)

Ground Trace of 8 Satellites in Two Planes (24 hrs)



No. of contacts with ground station in one day: 48 passes (24AM & 24PM)

Duration of Access of 1 satellite with ground station: 60.12mins
Total Access time of 8 satellites with ground station: 480.96mins (8.01hrs)

Summary of Constellation options

Proposed sensor options for the constellation

- **2 medium resolution (30m,4bands) optical imaging satellite**
- **1 high resolution (5m) optical imaging satellite**
- **1 SAR (10-20m resolution) imaging satellite**

Constellation options

- **4 satellites in a single plane (24 passes per day)**
- **5 satellites in a single plane (30 passes per day)**
- **10 satellites in a single plane (60 passes per day)**
- **6 satellites in a two planes (36 passes per day)**
- **8 satellites in a two planes (48 passes per day)**

PRESENT STATUS OF NIUSAT……..

ALL SUB-SYSTEMS ARE IN BOARD-LEVEL TESTING…

PAYLOAD IS IN PDR LEVEL

Possible Collaborations…….

Joint development of

- High resolution optical payload
- High resolution SAR payload
- High resolution hyper spectral payload

- Specification and configuration can be worked out based on the DMC requirements
- Generic NIUSAT Bus can be offered for any payload upto 5Kg mass and 10W average power

Thank you