The Pre-4th Mission Idea Contest UNISEC Global

Rental Satellite for Space Education Development

From KYUSHU INSTITUTE OF TECHNOLOGY

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July 3, 2015

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Introduction

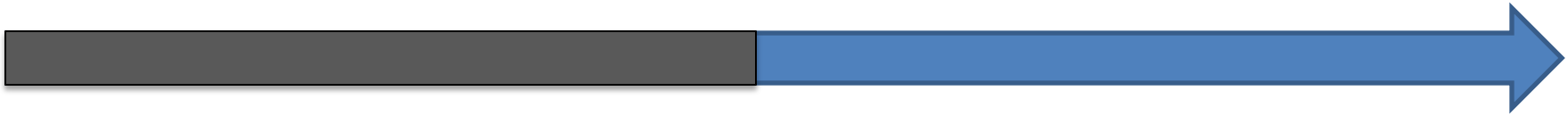
- Trend of Space technology development throughout world
- Situation of Education and Human resource development

Rationale and Issues

EMERGENCE OF NEW SPACE PLAYERS

27 space emerging countries

In 2013

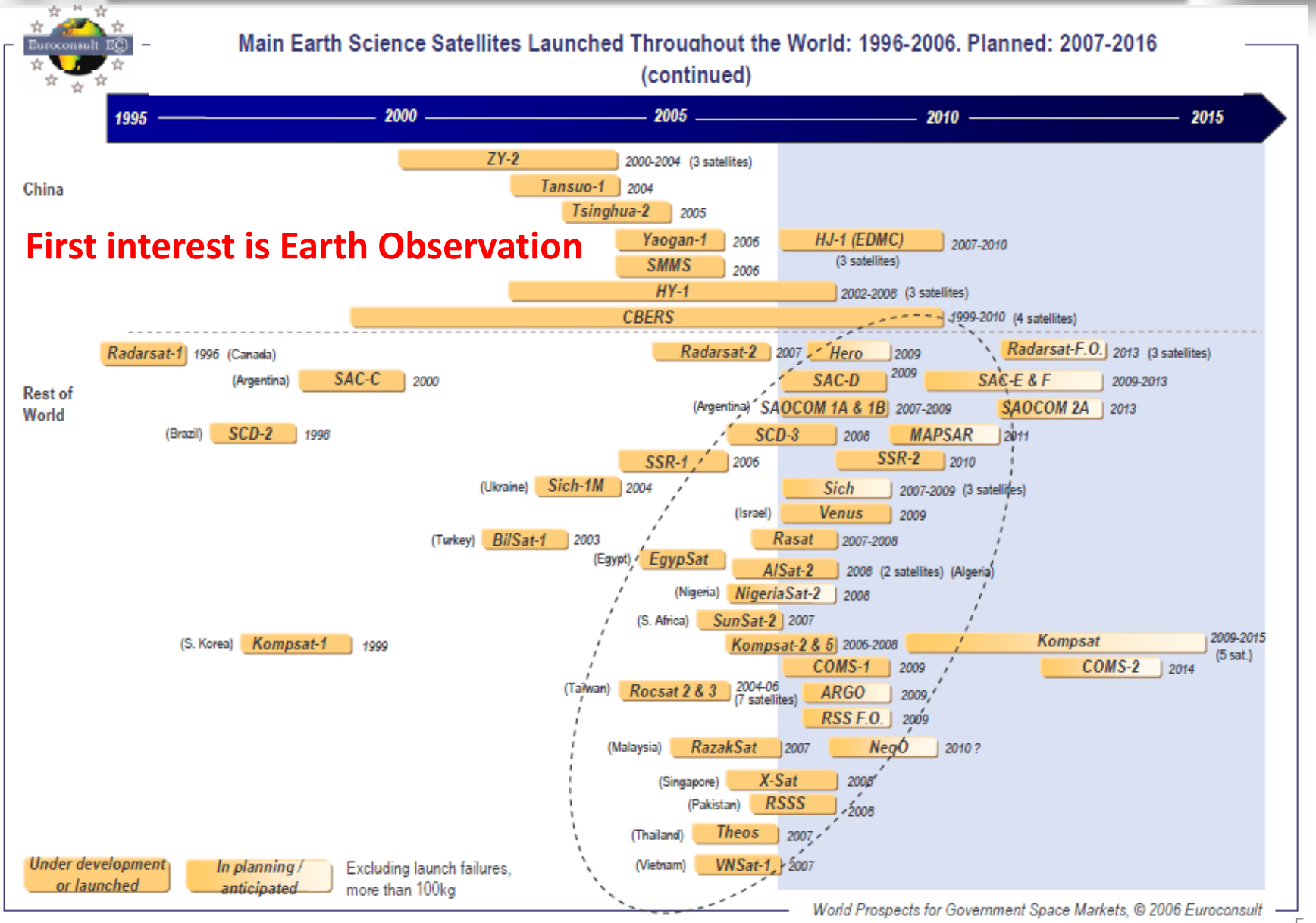


30 satellites Launched

38 satellites have being manufactured

Trends & Prospects for Emerging Space Programs. A Euroconsult Executive Brief | Published August 2013

Rationale and Issues



Space industries of Emerging Space Nations in the Global Market Place 2008 Steve Bochinger

Rationale and Issues

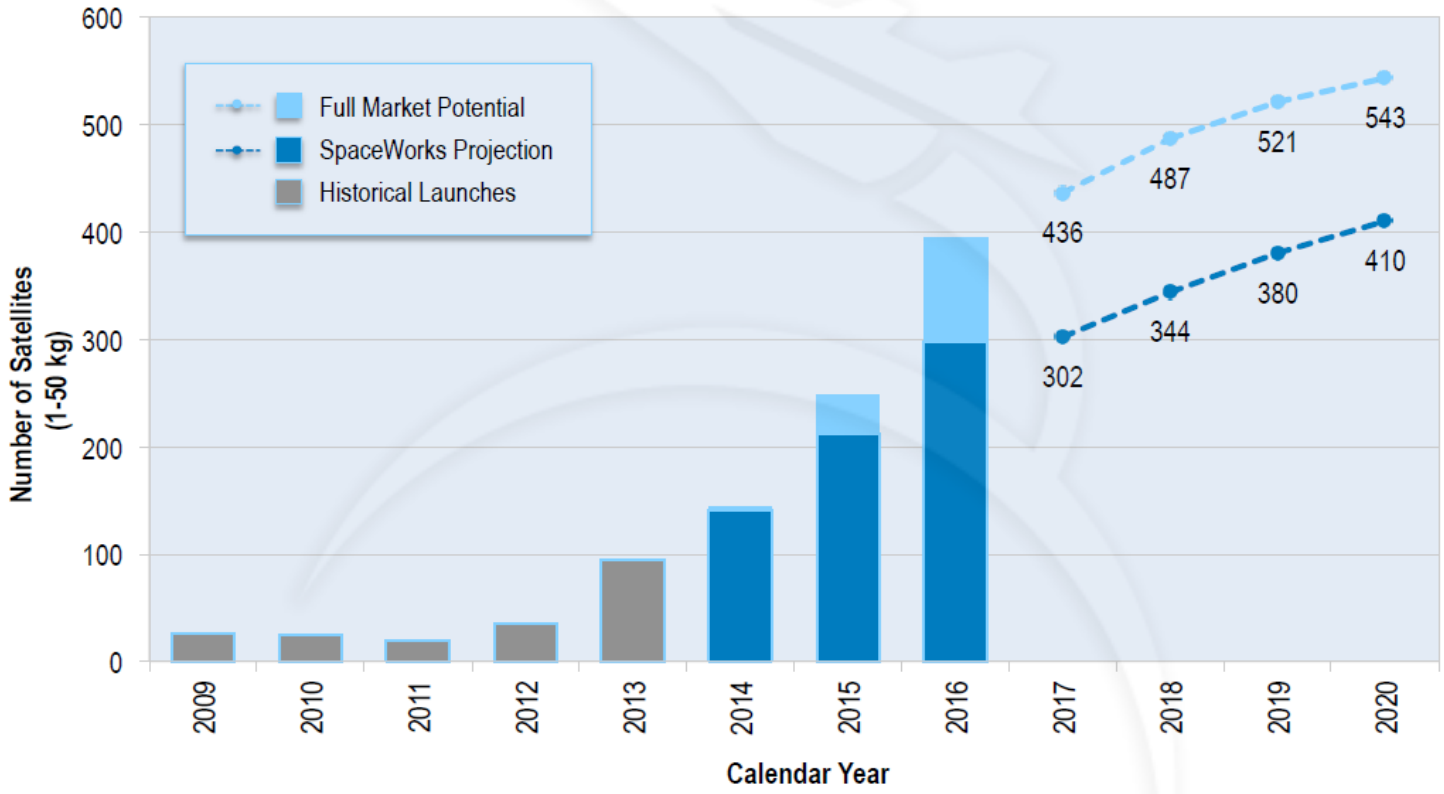
Space Engineering programs approximately
250 universities and institutions
40 countries worldwide

They try to develop their own satellites to provide practical training program

Educational Opportunities in Aerospace Engineering and Small Satellite Development United nations office for outer space affairs 2010

Rationale and Issues

Nano/Microsatellite Launch History and Projection (1 - 50 kg)



The Full Market Potential dataset is a combination of publically announced launch intentions, market research, and qualitative/quantitative assessments to account for future activities and programs.
The SpaceWorks Projection dataset reflects SpaceWorks' expert value judgment on the likely market outcome.

Over than **2,000** satellites will require a launch from 2014 to 2020

Rationale and Issues

Issues

- Space Debris

  More than 500,000 pieces of debris in orbit.

- Satellite development and launch cost is too high

Space Debris and Human Spacecraft July 3, 2015 Editor: Mark Garcia

Solution

You can control your rented satellite as you want

“ Rental Satellite ”

Benefits

- To provide sustainable “real” practical training for Space Engineering courses syllabus
- To contribute to decrease Space debris
- Low-cost and fast usage of satellite for users
- To increase collaboration between Space developed country and Space emerging countries

Mission Objectives

1. Provide atmospheric measurement data.

2. Provide Earth observation data to the end users.

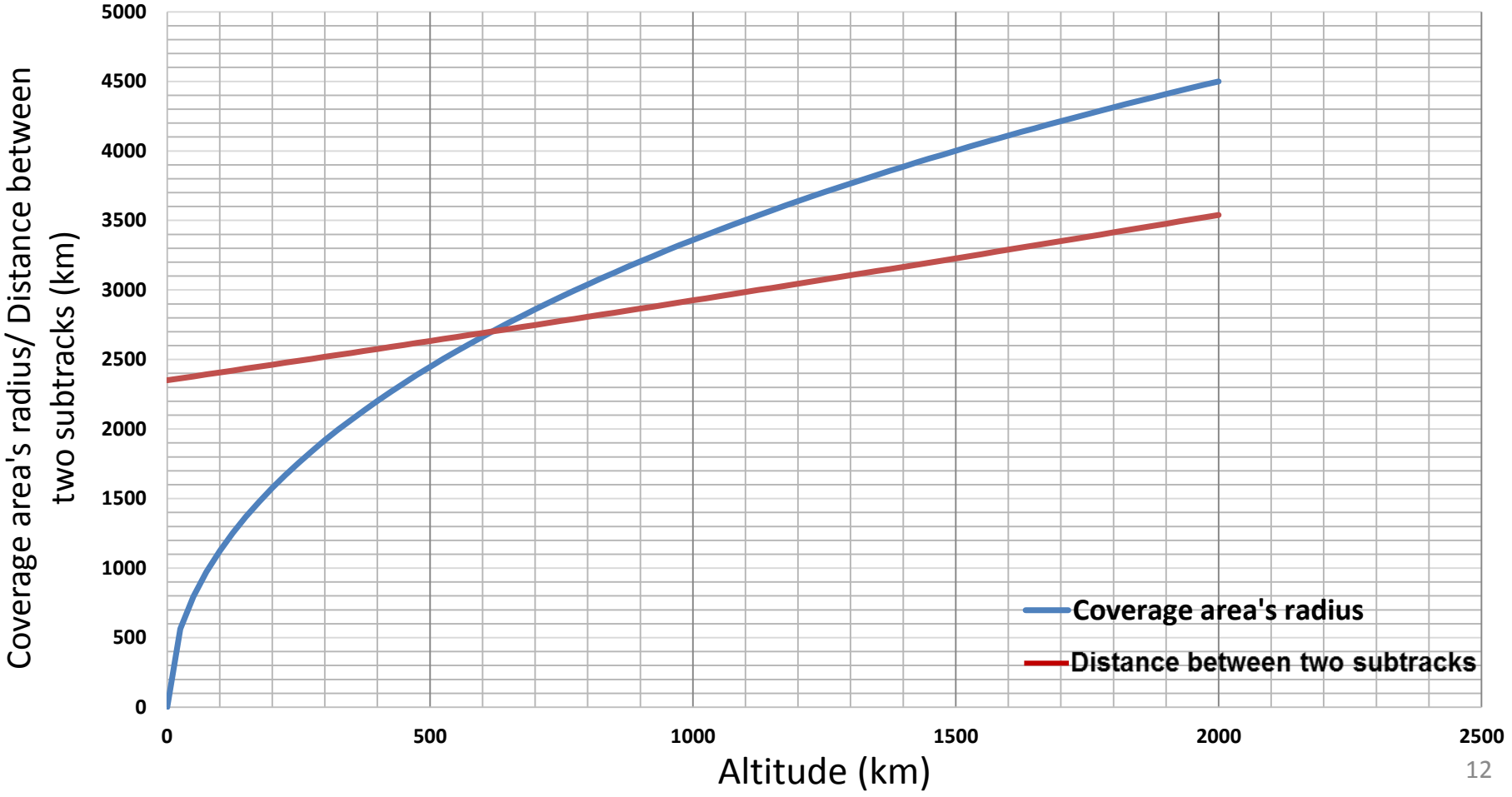
3. Provide users opportunity to communicate with the satellite at least 4 times per day.

4. Demonstration of Attitude Determination and Control System.

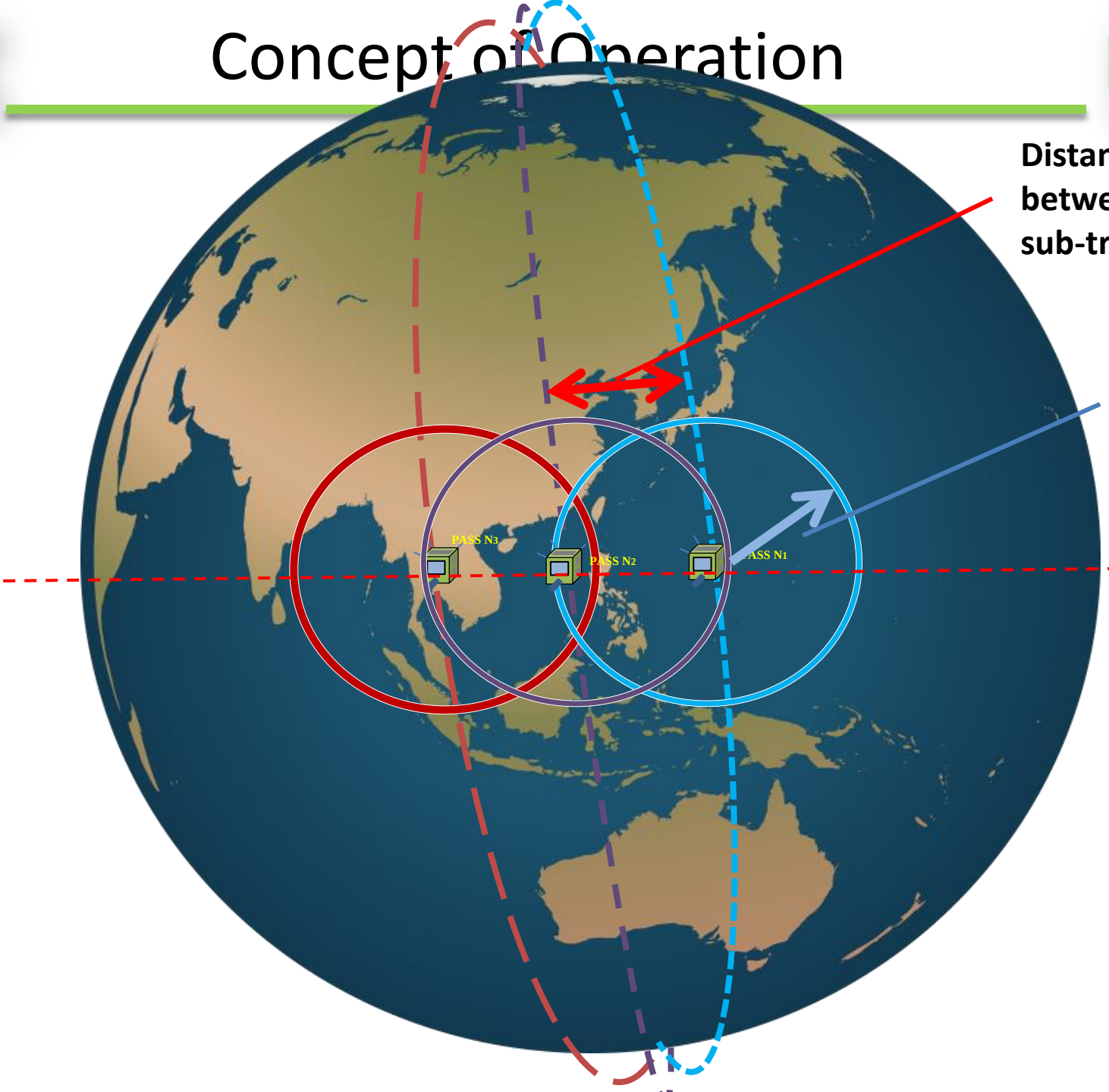
5. Users can test their algorithm checking in orbit

Concept of Operation

- Orbit is sun-synchronous orbit with inclination of 98 degrees.
- Altitude is above 625 km.



Concept of Operation



Concept of Operation

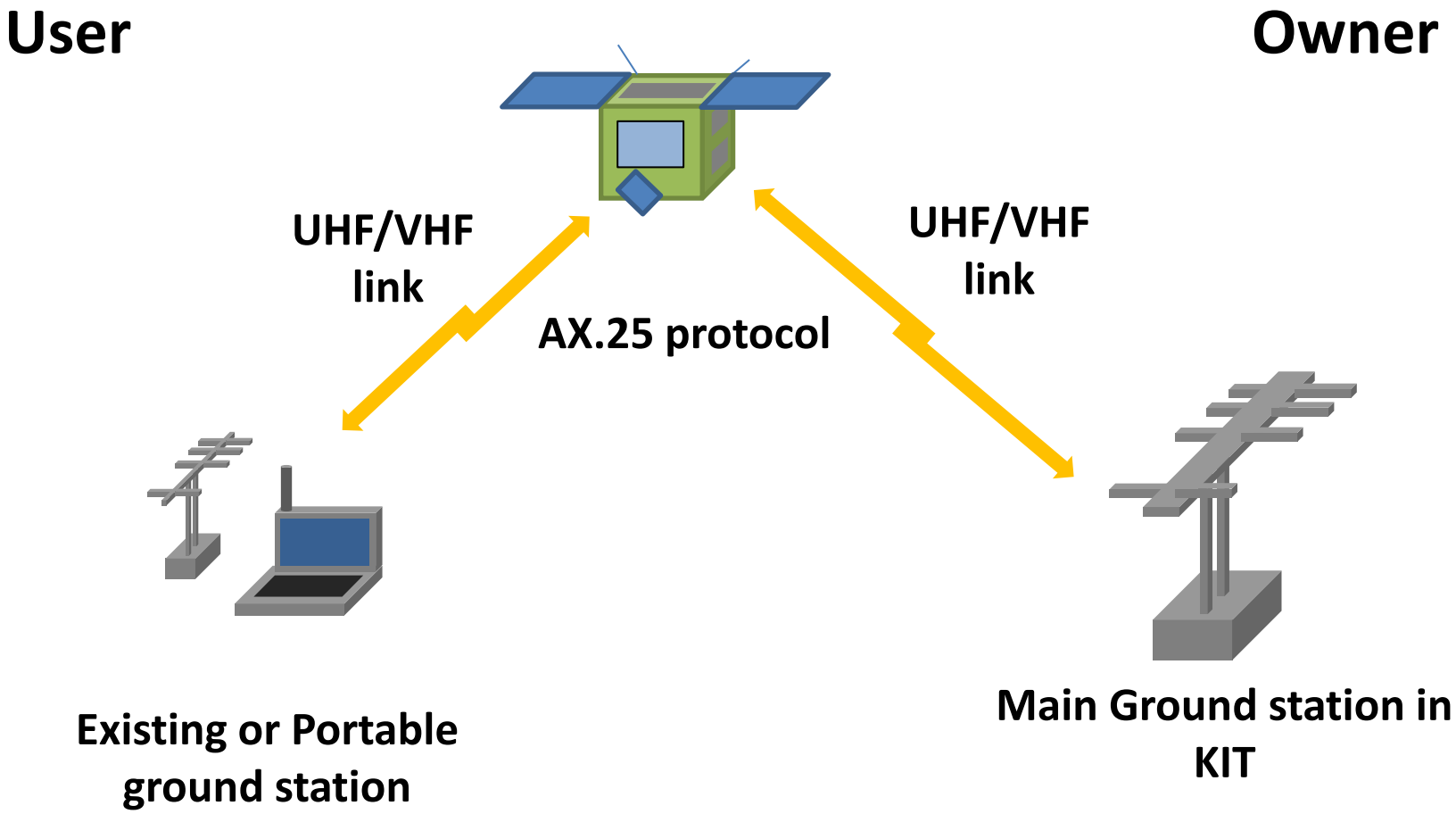
Total communication time per day (minutes)

Altitude (km)

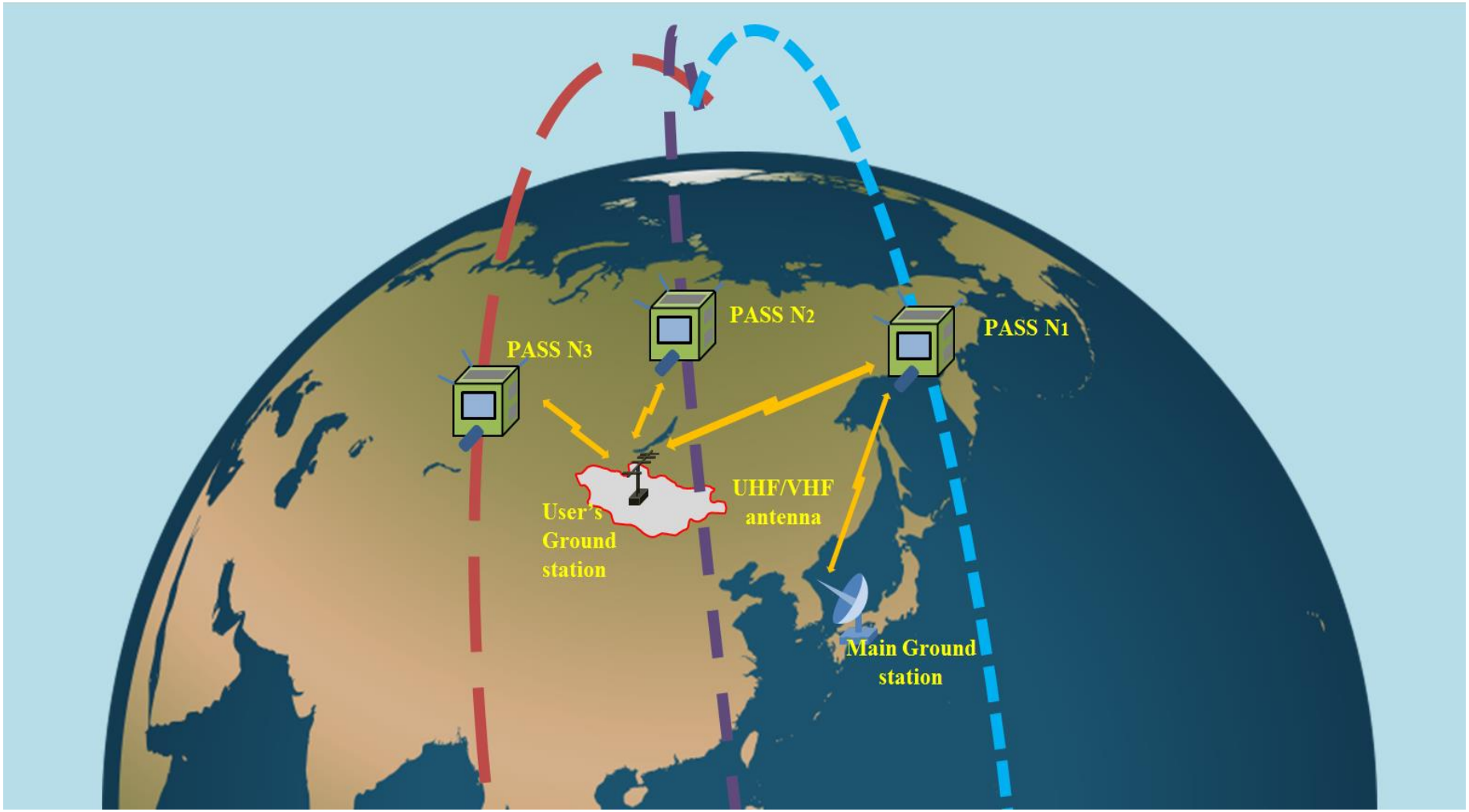
Latitude	400	500	600	700	800	900	1000
90	154.3	166.9	186.3	205.3	217.1	225.5	241.8
80	140.3	157.4	176.3	196.6	211.1	218.0	234.9
70	104.5	117.6	134.0	156.3	177.3	189.0	209.1
60	66.6	90.3	106.3	123.4	144.2	147.7	162.5
50	48.1	60.9	69.8	83.6	95.4	101.6	120.1
40	36.8	42.5	52.6	65.5	73.5	79.5	90.5
30	35.2	40.5	49.2	56.5	59.2	61.0	70.0
20	32.8	37.6	45.1	49.0	55.1	59.7	66.4
10	28.8	33.1	40.2	48.3	54.0	58.3	66.7
0	24.3	26.5	39.9	47.4	52.8	56.7	67.1
-10	21.3	26.8	39.2	46.5	52.9	60.6	68.2
-20	24.0	34.9	44.6	52.9	58.5	71.1	76.7
-30	31.5	39.4	47.5	55.6	69.3	77.0	81.7
-40	35.9	42.2	54.1	66.7	75.3	82.0	91.4
-50	42.5	56.7	69.9	80.0	95.0	105.6	114.5
-60	66.5	87.7	104.8	117.9	128.5	140.6	151.9
-70	98.7	114.2	133.8	144.7	165.6	188.9	194.9
-80	131.6	154.9	176.0	183.7	201.1	217.9	218.5
-90	144.6	166.2	186.3	191.7	208.8	225.5	226.1

Concept of Operation

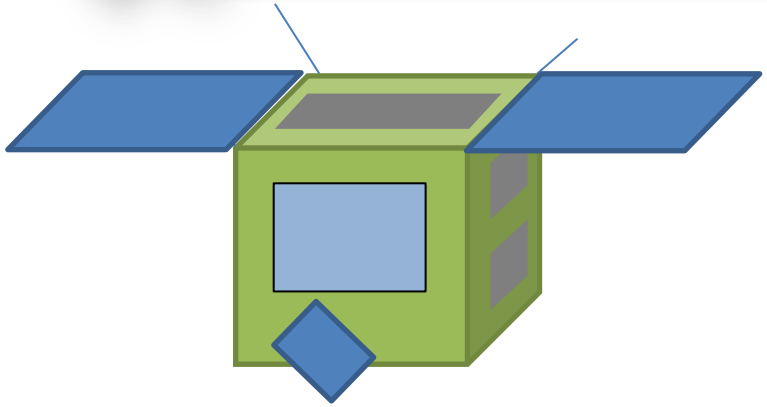
GROUND SEGMENTS



Concept of Operation



Concept of Operation



SPACE SEGMENT

Satellite's Mass and Power budget

Subsystem	Mass(Kg)	Power(W)
Payload	1	2
ADCS	2.5	5
EPS	2	-
C&DH	0.5	1
COM	1.5	0.5
Thermal	0.5	-
STR	5	-
Sum	13	8.5
Margin	2	1
Total	15	9.5

Structure

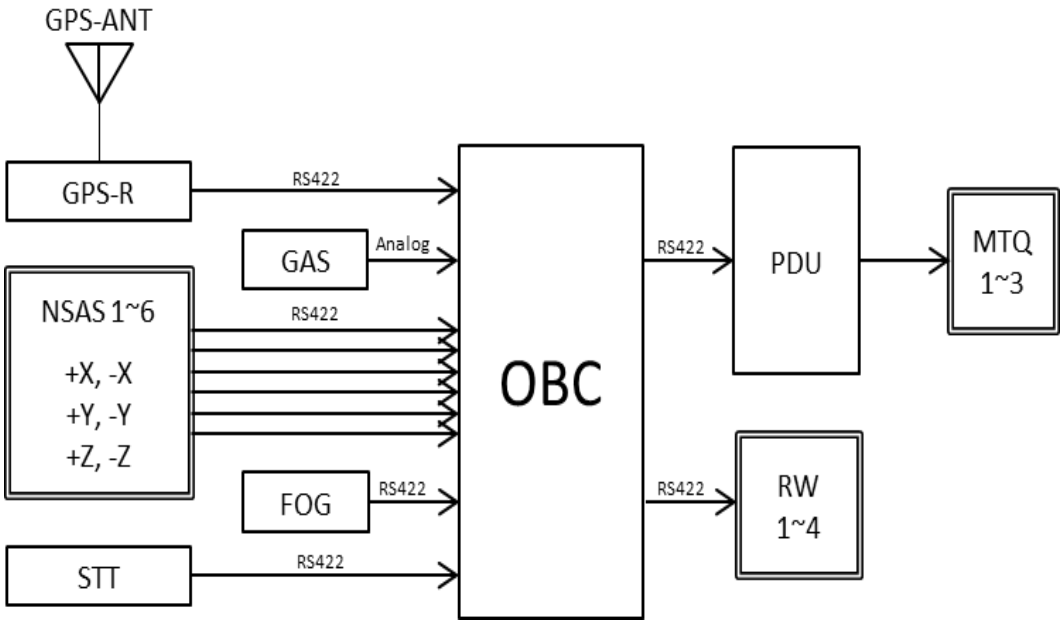
- Deployable Solar paddles
- Size < 30x30x30cm

Payload:

- Low Resolution Camera
- Atmospheric sensors

Key Performance Parameters

Attitude Determination and Control System



ADCS Block Diagram

Sensors:

NSAS (Non-spin Solar Aspect Sensor)

GAS (Geomagnetic Attitude Sensor)

STT (Star Tracker)

FOG (Fiber Optical Gyroscope)

GPS

Actuators:

RW (Reaction Wheel)

MTQ (Magnetic Torquer)

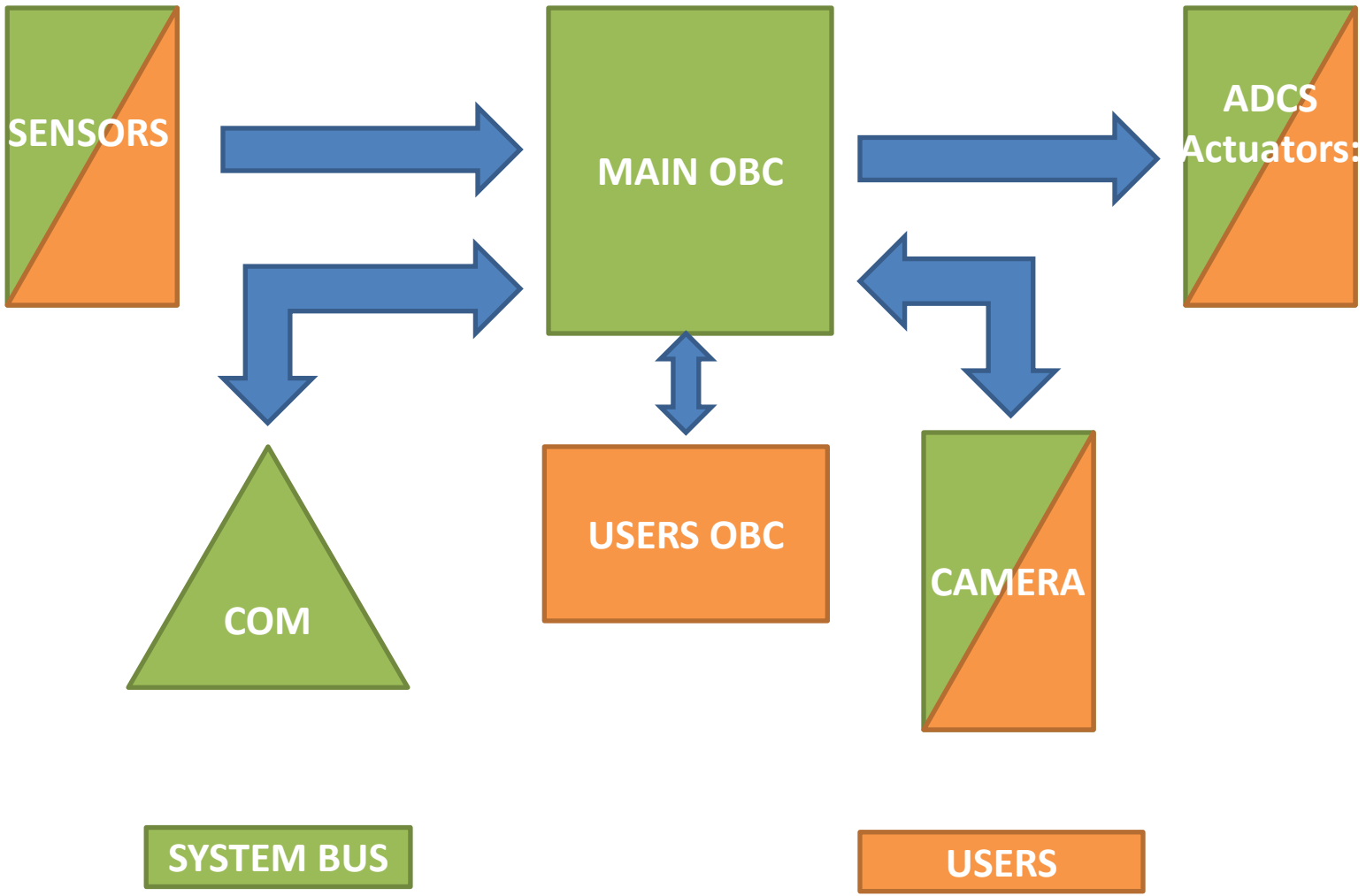
Key Performance Parameters

Possibility of Users

- To control satellite and take atmospheric data (Level 1)
- To capture images by low resolution camera (Level 1)
- Algorithm checking (Level 2)
  - OBC algorithm,
  - Camera algorithm
  - ADCS algorithm

Key Performance Parameters

Block diagram of internal sub systems



Implementation

Estimation of total life cycle cost [6]

<Satellite Cost>	Specifications	Cost (M$)
1.1 Bus Cost	Low level bus <20 kg, Size 30x30x30 (mm)	**0.3**
2.1 Payload Cost	Low resolution (GSD 50m), 200 x 200km	**0.1**
	Atmospheric Sensors	**0.1**
<Ground Station Cost>		
3.1. Ground station development	Amateur Very High Frequency (145 MHz) and Ultra High Frequency (435 MHz)	**0.05**
3.2 Operation Cost (On the main Ground station and Rentals Ground stations)	Engineers and Maintains	**0.1**
3.3 Management Cost (per one mission, for one time)	Prepare to operation on users ground stations	**0.1**
<Launch Cost>		
4.2 Single satellite launch as a piggyback satellite	The satellite launch cost to coordinated orbits	**1**
Total Cost		**1.75**

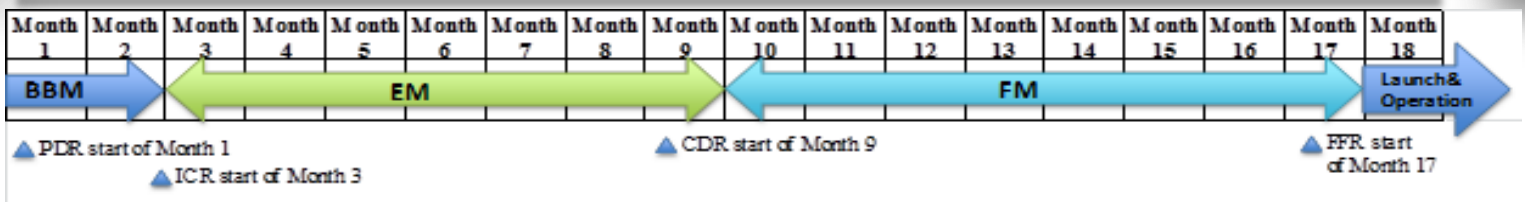
Small satellite cost model Prof. Nakasuka's

Implementation

Estimated revenue and benefit

	Initial investment (USD)	Users payment per 1 month (USD)	Estimated total revenue for 60 months (USD)	Profit for 60 months (after 60 months all revenue becomes profit)(USD)
Built and operation	750000	15000	900000	150000
Launch	1000000	20000	1200000	200000
Total	1750000	35000	2100000	350000

Implementation



BBM (bread board model) Phase tasks	*EM (Engineering model) Phase tasks*	*FM (flight model) Phase tasks*
Until PDR () • Sub-systems design • Sub-systems development separately • PDR objectives – demonstrate feasibility using hardware (Testing, analyses, etc…) • STM Development and testing PDR to ICR • Risk management 1 • Bus sub-systems integration • Missions integration • Table-sat 1: Bus+ missions universal board integration and testing • ICR objectives- demonstrate interfaces are working properly, validate design to move to EM	Until CDR • Sub-systems EM design • Integration with other sub-systems • EM structure development • EM thermal model development • EM environment testing • EM assembly, integration, and testing (EM AIT) • Table-sat 2 • Risk management 2 • Safety Review 1&2 CDR Objectives • Demonstrate satellite workability as a whole • Validate detailed design and interfaces	Until FRR • Manufacture of FM parts • Integration FM sub-systems • FM structure development • FM thermal model development • FM environment testing • FM assembly, integration, and testing (FM AIT) • End to end operation testing • Risk management 3 • Safety Review 3 FRR Objectives • Demonstrate satellite is safe to fly as piggy-back • Demonstrate satellite proper workability • Demonstrate satellite is ready to be delivered

Project schedule

Expected (Possible) Results

We have estimated 5 years (60 months) life time of operation in orbit, and during this time expected results as below:

- Minimum success: The satellite can provide the opportunity for at least 5 countries or institutions without a dedicated satellite to download data.

- Full success: The satellite can provide the opportunity for users in every country in the world

- Extra success: The satellite can provide the opportunity for users in every country to obtain data, control the satellite and further some companies would pay money to use this service for more than 5 years.

Thank you!