Development of Microsatellite to Detect Illegal Fishing "MS-SAT"

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India
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Thailand
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ITB


THE PHILIPPINES
MALAYSIA
Kalimantan
Sumatra
Sulawesi
Papua
Maluku
Java
Nusa Tenggara
EAST TIMOR
Bali
AUSTRALIA

Need

- Indonesia is a country consisting 17500 islands
- Most of the territory is sea (64.85%)
- Economy depends on maritime activities (fishing, shipping of people, goods, natural resources, and offshore drilling)

Illegal fishing

Maritime Disaster

Piracy

Mission Objective

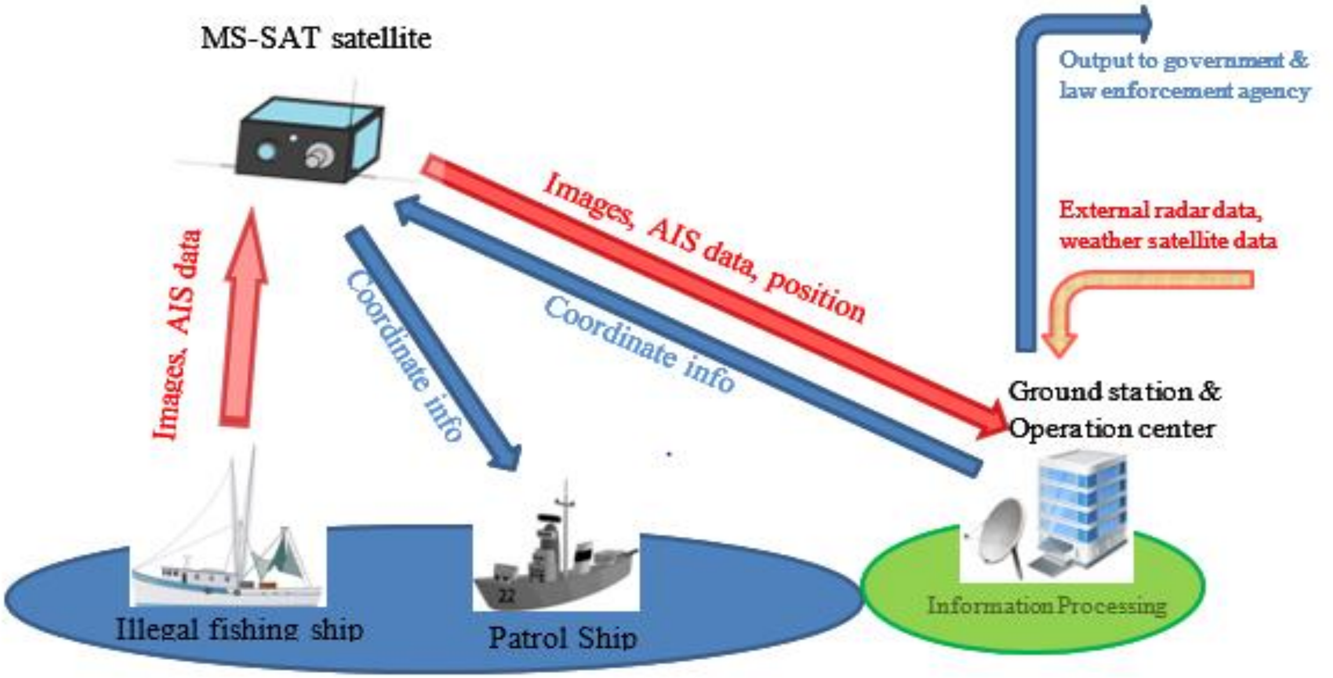
Primary Objective

1. Detect and locate potentially illegal fishing ship using satellite image, AIS data, and external sources.

Secondary Objective

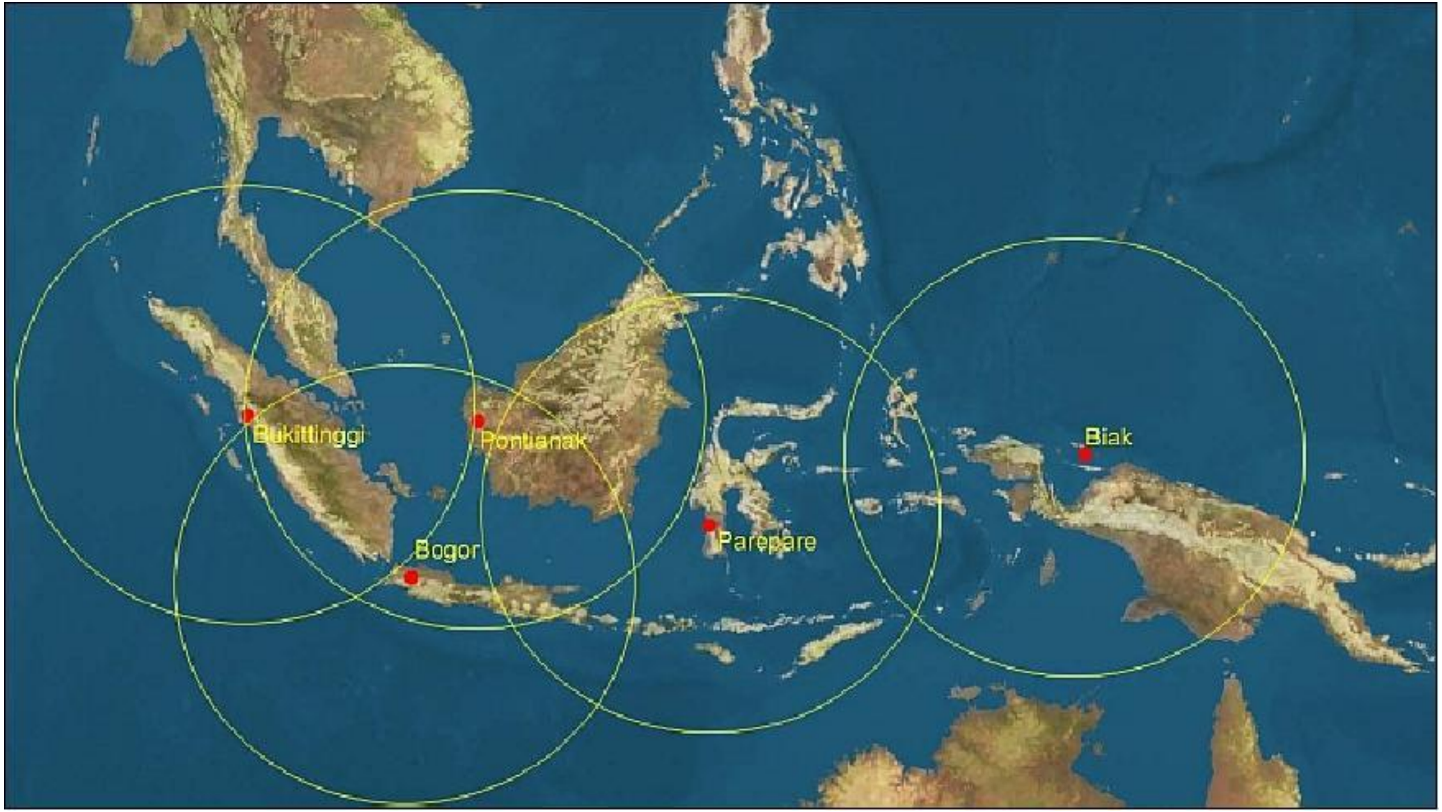
2. Monitor maritime environment and provide early warning for environmental disasters such as oil spillage.
3. Monitor maritime traffic and detect any ship illegally trespassing territorial water.
4. Provide intelligence of sea-based crime such as ship hijacking and piracy.

Concept of operation



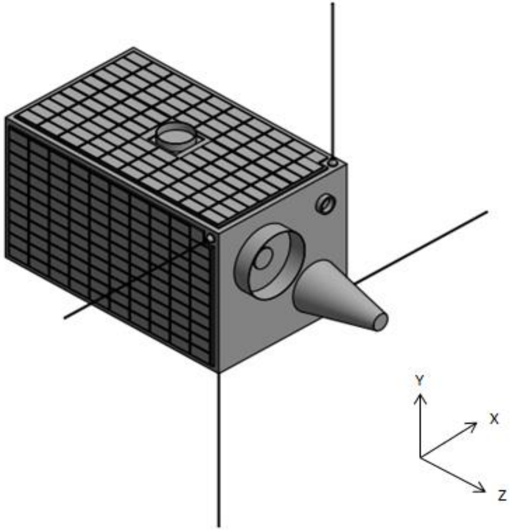
Concept of Operation

- Ground Segment
  - Operation center
    - Control the space segment
    - Receiving data from space segment
    - Receiving external input
    - Process all the information using image recognition software
    - Sending processed information to user segment
  - Multiple ground stations
    - Receive/transmit data to and from the space segment


Bukittinggi
Pontianak
Bogor
Parepare
Biak

- Space Segment

Satellite(s) in near equatorial low earth orbit with high resolution camera and AIS receiver. It will be used to detect vessels using high resolution imaging.



- User segment

Device that can receive processed information from operation center. Used on patrol boat, law enforcement agencies, etc.

- Launch segment

Piggyback payload to a larger satellite launch

ITB

Key Performance Parameters

- Ground Sampling Distance
  - Sensor must have GSD of 4 m to detect ships or other object
- Target Pointing
  - Be able to point target with less than $0,2^0$ of accuracy

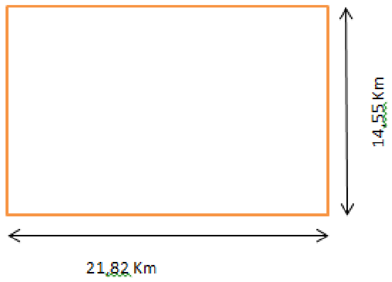
- Potential swath coverage
  – Have a potential swath coverage of more than 300km
- AIS Receiver Coverage
  – Have coverage radius of at least 400 km
- Datalink Bitrate
  – Able to transmit all the data gathered within a single pass of ground station

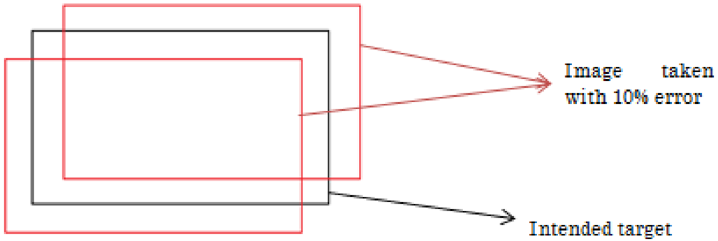
Why 4m?

Because illegal fishing vessel are relatively large in size; they need to travel far and stay for days. Able to deploy seines and can store large amount of fish on its hull

Why 0,2^{0} of accuracy

It's based on the assumption than 10% error from the width of the image is acceptable.

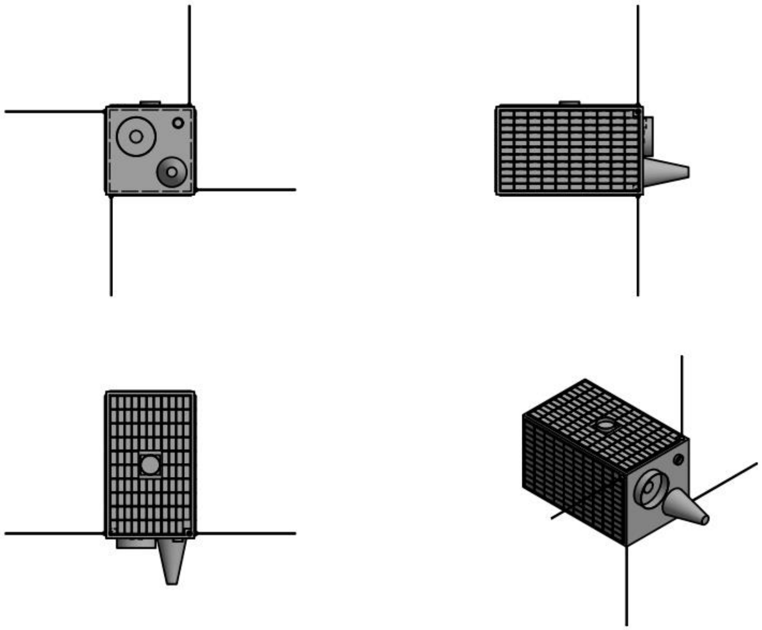




Space Segment Description

- Structure

  Made from Al 7075-T6
- ADCS
  - Reaction wheels
  - Coils
  - Gyros
  - Star sensor
  - Sun sensor (solar panel)



Payload

Primary camera

- 1000mm focal length lens (mirror lens)
- CMOS sensor with 6576 x 4373 resolution.
- View angle of $2{,}5^0$
- GSD of 3,32 Km
- Potential swath coverage of 364 Km, pan angle $\pm 20^0$

- Secondary camera
  - Aiming the satellite to point a specific location
  - Have a wider field of view
- AIS Receiver
  - Receive AIS information from vessels
  - Used to identify and locate vessels

Power Controller, Command, and Data Handling

- Contains processor, RAM, SSD, internal clock, PCDU, fuses, and input cable
- Data from the sensor will be processed in PCC&DH
- Regulate data transmission
- Act as Tracking, Telemetry, and Command

Communication System

- UHF Transceiver and Antenna

  Receiving command and sending feedback from ground station.
- VHF Transceiver and Antenna

  Relay information from ground station to user segment
- X-Band Transmitter

  Transmit data from the sensors, such as images and AIS data

Power system

- Battery
  - Lithium Ion with 8x8 cells
  - Voltage output 28V
  - Capacity 336 Wh
- Solar Panel
  - GaAs cells, triple junction
  - Power output estimate: 28W

Power Budget

All units in Watt

Device\ Mode of Operation	Picture	Transmit	Target Pointing	Momentum Bias	Tumbling
PCC&DH	26.11	26.11	26.11	2.5	2.5
Reaction Wheel	8	3	8	3	
Coils	1.5	1.5	1.5		
Gyros	3.8	3.8	3.8		
Star Sensor	2.4	2.4	2.4	2.4	
Primary camera	6.6				
focus motor	0.7				
Secondary camera	0.8		0.8		
AIS Receiver	0.8	0.8	0.8		
GPS Receeiver	0.125	0.125	0.125	0.125	0.125
UHF Transceiver	5.64	5.64	5.64	0.3	0.3
VHF Transceiver	2.82	2.82	2.82		
X-Band Transceiver		22			
Total	59.295	68.195	51.995	8.325	2.925

Mass Budget

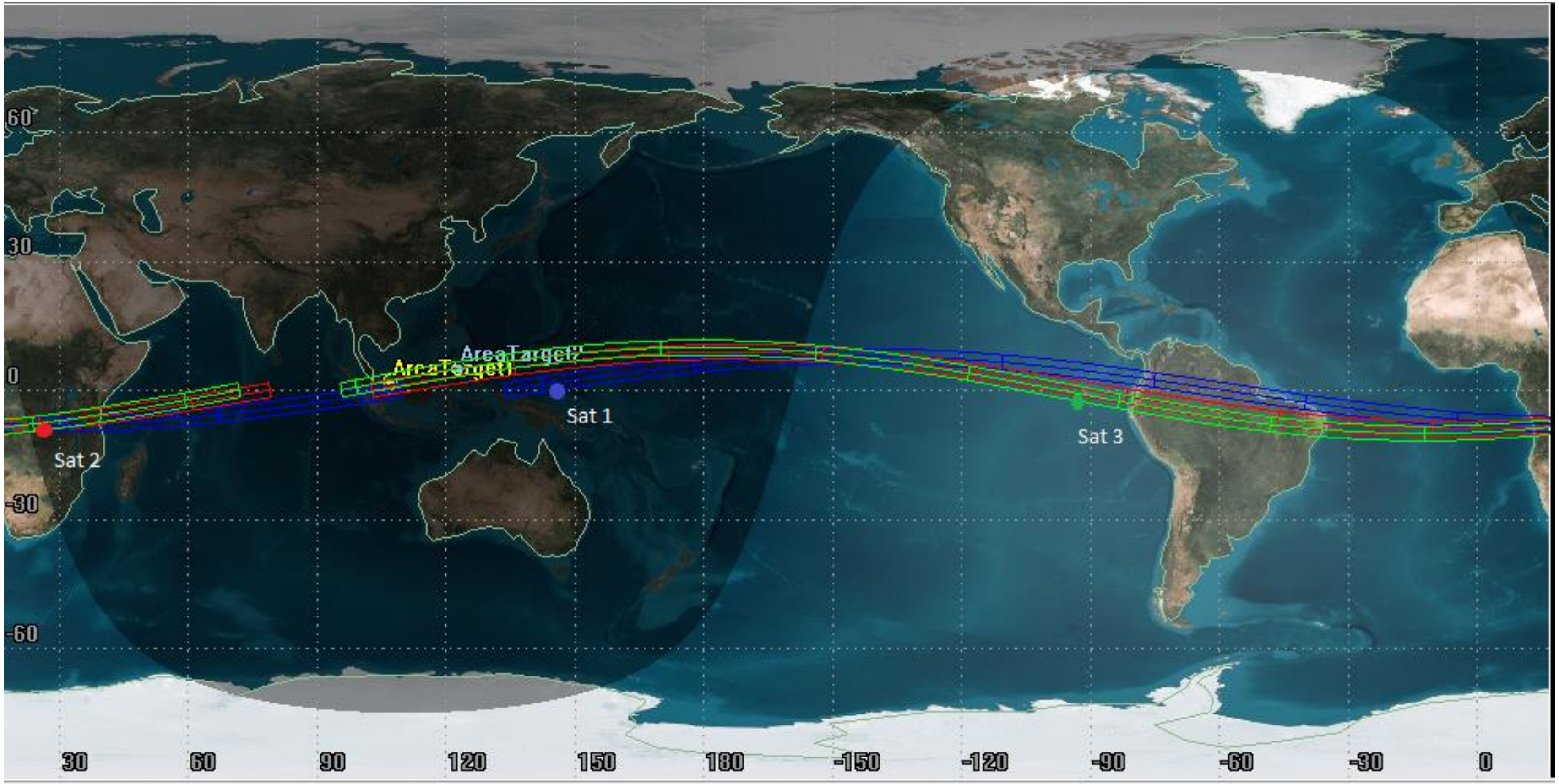
Component	Mass (g)	Component	Mass (g)
Structure	**12500**	**PCCD&H**	**3400**
ADCS	**5636**	PCDU Module	2500
Gyro X,Y,Z []	16	Harness and connector	900
Reaction Wheel X,Y,Z	3000	**Communication**	**2035**
Damper X,Y,Z	950	UHF Transceiver (2)	50
Coil X,Y,Z	1200	UHF Antenna (2)	360
Star Sensor	470	VHF Transceiver	25
Payload	**2372**	VHF Antenna	200
Primary Camera & Lens	1272	X-Band Transmitter	1000
Focusing Motor for primary camera	500	X-Band Antenna	400
Secondary camera & Lens	170	**Power System**	**5100**
AIS Receiver	55	Battery	3300
AIS Antenna	300	Solar Panel	1800
GPS Receiver	25		
GPS Antenna	50		
		Total	31043

Orbit

- Orbit used for our mission: near-equatorial orbit.
- This orbit suited the most due to Indonesia's geographical shape and location
- Orbital inclination between 8^0-12^0 will be best suited to this mission
- Orbital altitude 500km above earth surface.

Constellation

- 3-satellite constellation is planned
- True anomaly difference ±120^0
- Inclination 8^0-12^0
- 1 or 2 satellite is sufficient to do the mission, but with reduced capability.
- From simulation: a constellation of three satellites, the revisit time varies between 14 hours to 0,5 hours. For a single satellite the revisit time varies between 21 hours to 7 hours



60
30
0
-30
-60
AreaTarget2
AreaTarget1
Sat 1
Sat 2
Sat 3
30
60
90
120
150
180
-150
-120
-90
-60
-30
0

Implementation Plan

- Involving government agencies, universities, law enforcement agencies, and navy.
- Design stage involving national space agency, universities, while receiving inputs from government agencies and companies with space experience
- Engineering model manufacturing and test will be done by national space agency while receiving imputs from universities

- Flight model manufacturing, system integration, flight model test & evaluation, environmental test, and launch vehicle integration will be done by National Space Agency with active involvement from universities.
- Launch is done by lauch vehicle services as a piggyback to a larger satellite using similar orbit.
- After orbital deployment, the satellite will be operated by joint operation center involving LAPAN, government and law enforcement agency, the Navy, and universities.

	2016						2017												2018												2019	
	Jul	Aug	Sep	Oct	Nov	Des	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Aug	Sep	Oct	Nov	Des	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Aug	Sep	Oct	Nov	Des	Jan	Feb
Conceptual Design	■	■	■																													
Preliminary Design				■	■	■	■																									
Detail Design								■	■	■																						
Engineering Model Manufacturing & Test											■	■	■	■	■																	
Flight Model Manufacturing																■	■	■	■	■												
System integration																					■	■	■									
Flight Model Test & Evaluation																								■	■	■	■					
Enviromental Test																												■	■			
Launch Vehicle Integration																														■	■	
Launch																																■

Project Risks

1. Launch vehicle failure, as this will severely delay the project and led to budget overrun.
2. ADCS failure. This will render the satellite useless for taking images. Intensive test and evaluation can reduce this risk.
3. Loss of communication. This will mean the end for the mission. Implementing redundant architecture and testing can reduce this risk.

4. Sensor failure, reduce the capability of the system /failure of the space segment. It is an important risk to address. Some of the subsystem is off the shelf component (not space-rated). Test and evaluation can reduce this risk
5. Battery failure. This will reduce the performance of the satellite, as it can only operate with direct sunlight and limited power. Using reliable battery and tests can reduce this risk.

6. Weather uncertainty. Bad weather and large clouds can hinder the ability of the camera to take a good image. It can also disturb the communication and AIS signal. Using weather satellite data can overcome these shortages by planning the satellite to take images in certain weather condition.


ERNEST SEBASTIAN
AE 2013
BINTANG A.S.W.A.M
AE 2013
The 4th Mission Idea Contest
for Micro/Nano Satellite Utilization
Municipality of Avren, city of Varna, Bulgaria

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Thank you for your attention!
Any Questions?