Environmental Systems Applications of Geomatics Engineering (EnviSAGE) Research Laboratory, Department of Geodetic Engineering, College of Engineering, University of the Philippines Diliman

Title: THERMAL INFRARED REMOTE SENSING USING NANO-SATELLITES FOR MULTIPLE ENVIRONMENTAL APPLICATIONS

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Organization: Environmental Systems Applications of Geomatics Engineering (EnviSAGE) Research Laboratory

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☐ **We apply to Student Prize.**

☒ **Please keep our idea confidential if we were not selected as finalist/semi-finalist**

1. Key Concept and Business Impact on Society and Environment

The Mission Concept aims to utilize nano-satellites with Thermal Infrared (TIR) remote sensing capabilities to produce TIR imageries as data source for land surface temperature (LST) that can be integrated to terrestrial thermal measurements for use on the following environmental applications:

a. Pre-earthquake Temperature anomaly studies for earthquake prediction
b. Urban heat island effects and green urbanscape studies
c. Temperature analysis for typhoon predictions
d. Studies on vegetation stress in agriculture to analyze and predict harvest conditions
e. Regional water stress and drought assessment
f. Identification and monitoring of Volcanic activity
g. Habitat classification, and analysis of suitability and changed trends in ecosystems
h. Coastal environment studies
i. Other studies on climate change

The TIR imageries are intended to be available, specifically for agencies and organizations who are involved in projects and researches on environmental protection and management and disaster risk mitigation.

2. Business Model Structure

This service is conceived to be available through the Philippine National Agency for Space (PINAS), an envisioned joint venture between the Department of Science and Technology – Philippine Atmospheric Geophysical and Astronomical Services Administration (DOST-PAGASA) and the University of the Philippines Training Center for Applied Geodesy and Photogrammetry (UP-TCAGP).

The Business Model that will be implemented is shown in Figure 1 below, wherein PINAS will be the main agency to handle the operations and maintenance of the Mission Idea. The target end user clients are initially the Environmental Organizations, Private Individuals and

Companies, Academic Institutions and Government Agencies. For the latter two target clients, alternative payment schemes or even Memorandums of Agreement may be considered as appropriate.

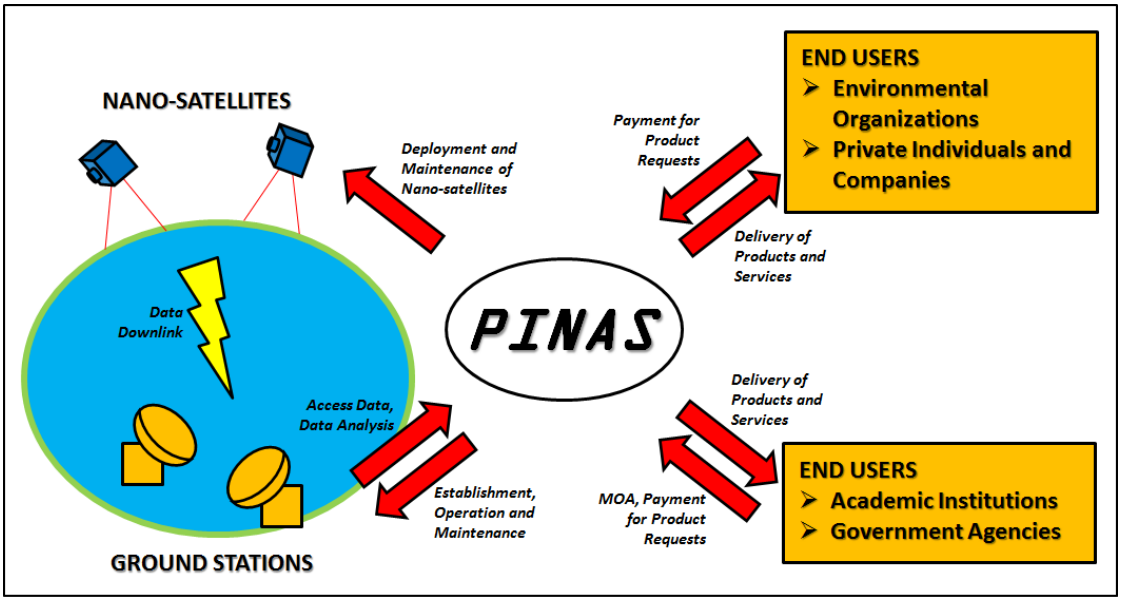

Figure 1. Business Model for the Mission Idea

Using the agency's website, updated thermal imagery from the nano-satellite system will be available online. Raw and Processed data and specific mission requests may also be available for clients on demand. The products will be available to the clients either through online FTP or through arranged shipping process. The service will be initially available for the ASEAN region but will eventually expand to provide data for the global community. The initial price offering for the TIR product is shown in Table 1 below:

Table 1. Initial Product Pricelist for the Mission Idea

PRODUCT/ SERVICE	DETAILS	NEW ACQUISITION PRICE ($)	ARCHIVE* PRICE ($)
Thermal Infrared Image	A 20km x 20 km image of the Area of Interest (0.5MB Compressed JPEG image) may be requested on demand, and downloadable through FTP or through shipping.	1000	500
Level 1 Image Processing	Systematic radiometric and geometric correction may be requested applied to the image which will be derived from data	*(FREE of charge, but adds to the product delivery time for new acquisitions)*	

	collected by the sensor and spacecraft to rotate, align, and georeference the image to UTM map projection.	

**Imagery is defined as "Archive" ninety (90) days after collection*

The initial product offering is intended to address the growing interest in micro-climate studies and the developments in the utilization of thermal infrared image data for multiple environmental applications including those enumerated in the Section 1 above. Specific data processing and statistical analysis may be added as future products.

3. Business Feasibility

Considering the Mission Idea Cost Model, the cost estimates are computed as shown in Table 2 below.

Table 2. Mission Idea Cost Model

	SPECIFICATIONS	UNIT COST (M$)	TOTAL COST (M$)
Bus Cost (2 satellites)	Medium (1 Mbps downlink speed)	2	4
Payload Cost (2 satellites)	Infrared thermal sensor (Temperature resolution 0.5 Kelvin, ground resolution 50m, 25 x 25km)	1.2	2.4
Ground Station Development Cost (4 stations)	1Mbps downlink speed	0.5	2
Launch Cost (2 satellites)	Coordinated "piggyback"	4	8
		TOTAL INITIAL COST (one time)	**16.4**
Ground Station Operation Cost (4 stations)	1Mbps downlink speed	0.2	0.8
Data Analysis Cost	Infrared thermal sensor	1	1
		TOTAL YEARLY COST (per one year)	**1.8**

With the above cost estimates, for the assumption of 3000 new acquisition requests for the first year of operation, then average yearly requests of 6000 for new acquisition and 3000 for archive for the succeeding years, a revenue stream for a Five-year period is projected as shown in the

Financial Estimates in Table 3 below. Return of Investment is met within Year 4 and positive profit is achieved thereafter.

Table 3. Projected 5-year Financial Estimates

	YEAR 1	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**
COST (M$)					
Total initial cost	16.4	0	0	0	0
Total yearly cost	1.8	1.8	1.8	1.8	1.8
TOTAL	**18.2**	**1.8**	**1.8**	**1.8**	**1.8**
REVENUE (M$)					
No. of New Acquisition Requests	3000	6000	6000	6000	6000
No. of Archive Requests	0	3000	3000	3000	3000
TOTAL	**3**	**7.5**	**7.5**	**7.5**	**7.5**
PROFIT (M$)	**-15.2**	**-9.5**	**-3.8**	**1.9**	**7.6**

4. Logistical Feasibility

The Mission idea for *Thermal Infrared Remote Sensing Using Nano-Satellites for Multiple Environmental Applications* is conceptualized to have the following key system specifications:

A. Payload and Bus Level of the Satellite

A Payload with specifications for **Temperature resolution** of 0.5 Kelvin, **ground resolution** of 50m, and **coverage area** of 25 x 25km is selected. This corresponds to Medium Bus level requirement and can generate an image size of 0.5MB for a 20km x 20km compressed JPEG image.

B. Number of Satellites (N)

Two (2) satellites will be deployed in a coordinated orbit with a revisit interval **L** equal to one day for both satellites, to get an averaged revisit interval of 0.5 days (L/N).

C. Number and Specifications of Ground Stations (G)

Four (4) ground stations will be established each with 1 Mbps downlink speed. This will give a downlink latency of 3 hours (12hrs/No. of Ground Stations). With these specifications, a total of 2,400 images can be downlinked per day (2400 x G x Downlink speed/Data size).

D. Launch Configuration

The 2 nano-satellites will be sent to orbit through coordinated "piggyback" launched.

5. Risk Analysis

Some of the risks that may be encountered in the proposed business model are as follows:

1. *Market Acceptance and Competition*

   The Thermal Infrared Sensing technology is not exactly new and there are other existing sensors that already provide both imaging and thermal. These competitors, direct or indirect, who are more established in terms of market presence, technical capability, and financial stability may act to offer equally or even more sophisticated products and services at lower costs.

2. *Financing and Financial stability*

   Availability of financial resources and sustaining funds for subsequent years of operations are of utmost concern. A yearly 1.8 M$ operation cost is needed to keep the service going. In the Business Feasibility in Section 3, 7.5 M$ is projected to be the average yearly revenue stream. However, the actual number of products requests per year will greatly depend on the demand and may vary each year.

3. *Organization*

   The idea of the PINAS is a joint venture between DOST-PAGASA and UP-TCAGP. Because the two are both under the Philippine government, there would be issues and concerns regarding the organization of the space agency to be established. Also, other institutions and agencies may want to be part of the venture which would entail a more complex organization scheme.

4. *Technical Capacity and Capability*

   The conceptualized Mission Idea needs sufficient technical capacity and capability in order to make the idea happen. This might require necessary researches, trainings and consultation with experts in the field of satellite missions.

References

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