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# Scientific basics for planning of remote sensing ground stationsin Vietnam

Le Minh Son, Chu Hai Tung, Nguyen Ngoc Quang, [1]Ngo Duy Tan [2]
[1](*Department of National Remote Sensing, Ministry of Natural Resources and Environment of Vietnam)*
[2](*Space Technology Institute, Vietnam Academy of Science and Technology)*

**Abstract:** The paper shall introduce basic research on planning of remote sensing ground stations which is expected to facilitates the relevant activities of Ministry of Natural resource and environment (MONRE) of Vietnam. Study on current status of existing ground stations, their utilization and future trend in Vietnam are performed to conclude on the realities, the need for ground station planning and its criteria.
**Keywords:** Remote sensing ground station, planning, multiple criteria analysis.

## I. INTRODUCTION

Remote sensing data are has been being effectively used in Vietnam to supports various applications including land-use monitoring, forestry, oceanographic study and environmental monitoring. Generally, their ground stations function to maintain the ground-satellite communication links, image processing and delivering products to end-users. Currently, Vietnam is operating one remote sensing system called VNREDSat-1 and more satellite systems and ground station are going to be invested in the coming time. In order to ensure the efficiency and maximized benefits gained for the users, their ground stations shall be scientifically and systematically assessed and allocated. Therefore research on scientific basics for the planning activities of the remote sensing ground stations is a must to support Vietnamese decision makers in the field of remote sensing activities.

Department of National Remote Sensing (MONRE), which is a key organization of Vietnam in charge ofremote sensing activities in Vietnam, has been in close cooperation with GISTDA (Geo-Informatics and Space Technology Development Agency) of Thailand for promoting space technology applications for both countries' benefit.GISTDA has started its remote sensing technology since 1982 by building a network of receiving stations for various satellites such as Cosmo-SkyMed KOMPSAT, LANDSAT-5, and RADASAT-2 and cooperated with Airbus Defence and Space (ADS, formerly known as EADS) to manufacture and launch of THEOS satellite in 2008. The organization is running huge facilities inSirachaKrenovation Park (SKP)for its space technology activities. [1]

Fig 2. GISTDA's premises in Krenovation Park in Siracha, Thailand

Experiences and lessons learnt from GISTDA have been shared with Vietnamese space agencies through expert exchange, workshops and training, especially in ground station operation and planning. Key criteria for site planning of remote sensing ground stations can be categorized tomanagement, finance and engineering. Thorough study and evaluation on these criteria shall provide important inputs and guarantee maximal return on investment of relevant projects.

## II. CURRENT STATUS ON REMOTE SENSING GROUND STATIONS IN VIETNAM

### 2.1 Overall of remote sensing ground station

Ground station for a remote sensing satellite is a complex system to perform the functions to maintain the satellite-ground link, processing and delivering the products to the end-users. It is composed of dedicated hardware, software and relevant infrastructure to support its operation. The configuration of a typical remote sensing ground station is depicted in the figure 1. The ground equipments can be divided into two main streams: image downlink and satellite control. The image-related equipments carry out the signal reception and payload data processing in order to capture the required images, generate and deliver the image products to the users. Additionally, the functions of satellite control and tasking must be done synchronously to maintain the optimal health and operation of the in-orbit satellite.

Last but not least, the infrastructure to accommodate the equipments and ensure the power supply, access, safety and reliability must be a key factor required to be studied and planned before the deployment of the station.

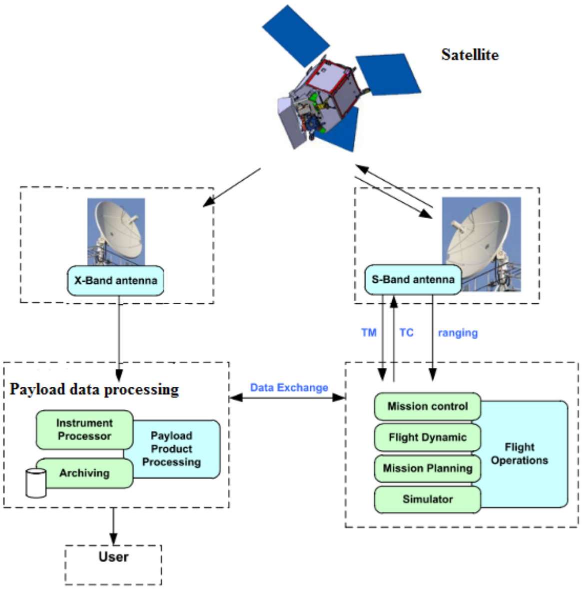


Fig. 1.Typical configuration of a remote sensing ground station

### 2.2 Current status of remote sensing ground station in Vietnam

Since 2007, MONRE has been operating a ground receiving station for SPOT and ENVISAT satellites and providing valuable space data for the local remote sensing community. SPOT-2, 4, 5 and ENVISAT satellites data covering the whole Vietnam territory were received, processed, delivered and utilized in various fields such as land-used mapping, environment, forestry and oceanography.

In 2013, in support for the VNREDSat-1 which is the very 1$^{st}$ remote sensing system of Vietnam, the above station has been upgraded in order to capture and process the satellite data. Currently the station is still maintaining its operation and providing high-resolution image products to local space agencies and facilitate international cooperation activities.

Beware of the strong needs for space data and its application to support the national development and international integration, Vietnam Government and space-related agencies such as MONRE remarkably focus on the goal to install more remote sensing ground stations with a view to diversify and intensify the space data sources. This trend has been strengthened and highlighted in Vietnam National strategy on research and application of space technology until 2020.

In future, Vietnam plans to own and operate the following stations:

- One primary ground station located in Hanoi (a Northern city of Vietnam)for dual-purposes of control and reception of radar satellites named LOTUSat-1 and LOTUSat-2 and one back-up station in Ho Chi Minh City.
- One SPOT-6 and SPOT-7 ground receiving station located in Hanoi.
- Ground stations for VNREDSat-2.

- One tracking and receiving station for Indian satellites located in Binh Duong province (South of Vietnam).

It can be realized that the Vietnam will have multiple data sources (optical and radar) with various ground stations located nationwide to meet emerging needs for space data. Different satellites with different system specification and variety of ground equipments and software place remarkable challenges for both decision makers and station owners including MONRE. This fact will naturally trigger the need and requirement on planning activity of ground station network in Vietnam.

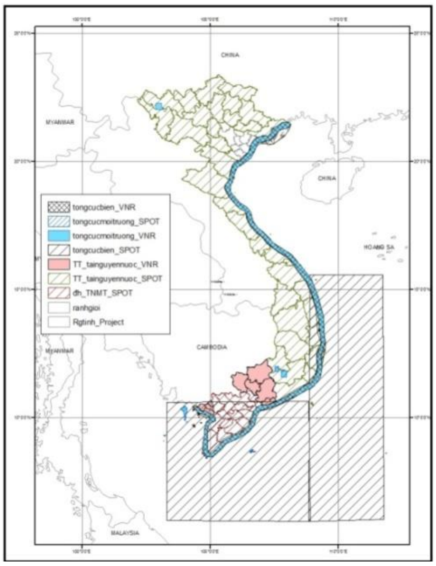

Fig. 2.Local need for remote sensing data by MONRE in 2016

## III. SCIENTIFIC BASICS FOR GROUND STATION PLANNING IN VIETNAM

### 3.1 Radio frequency interference (RFI)

Radio Frequency Interference (RFI) signals are man-made sources that are increasingly impacting radio link of remote sensing ground stations. RFI is of insidious nature, with some signals low power enough to go undetected but large enough to worsen radio signal and their transmission quality. This is a criterion of importance to be evaluated for any ground stations both before and during operation period.

The X-band ground station operated by MONRE encountered bad RFI several times and hindered the station capability to receive and process the image. The RFI detected by the station caused bad image and shown in figure 3 and figure 4.

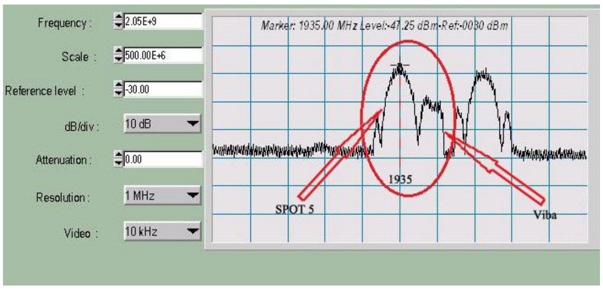


Fig.3.Unwanted signal detected in the MONRE’s remote sensing station

Bad radio signal caused unacceptable image.

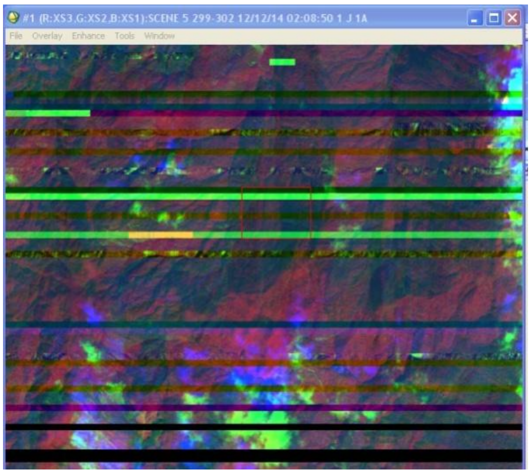

Fig.4. Noisy image caused by heavily impacted radio signal

Radio frequency spectrum is a valuable resource for satellite communication and being increasingly congested. Therefore, each country must have adequate measures to manage and protect the frequency bands for local use and to be in accordance with related international radio regulations. Currently, the use of the radio frequency spectrum is coordinated and regulated worldwide through the International Telecommunication Union (ITU). Radio regulations related to the remote sensing ground stations can be RR 5.311, RR 5.348, RR 21.16, RR 5.354, RR 5.389A , RR 5.389C, RR 5.402, RR 5.403, RR 5.447B, RR 5.462A, RR 5.488, RR 5.493, RR 5.530, RR 5.538, RR 5.556A , RR 5.558A, RR 5.562C, RR 5.562H, 9.11, 9.14, 9.21/C, 4.1.1d , 4.2.3 d. The regulations define the RFI details and measures to minimize harmful impacts on the ground stations. Below are samples of RFI thresholds for X-band remote sensing ground station recommended by ITU-R SA.1026-4:

| **Frequency band** | **Type of earth station** | **Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time** | **Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 0.0125% of the time. (This value is based on the 99.9% performance requirement in Recommendation ITU-R SA.1025-3)** |
|---|---|---|---|
| 8 025-8 400 MHz | 54.8 dBic antenna gain Recorded data playback System A | −145 dBW per 10 MHz | −133 dBW per 10 MHz |
| | 41.7 dBic antenna gain Recorded data playback (System B) | −135 dBW per 10 MHz | −127 dBW per 10 MHz |
| | 42.5 dBic antenna gain Direct data readout (System C) | −139 dBW per 10 MHz | −129 dBW per 10 MHz |

*Table 1.Interference criteria for Earth exploration-satellite (ITU-R SA.1026-4)*

### 3.2 Visibility analysis

Visibility is a key factor to evaluate the performance of a ground station. It is to calculate and simulate the surrounding area of the station which can communicate with the satellite in orbit. This factor will impact the duration of communication between the satellite and the station. That means it much depends on the surrounding obstacles such as high building and mountain and the terrain. Antenna height shall be a key input to simulate the visibility mask of a ground station.

Digital elevation model (DEM), or digital surface model (DSM)can be used for visibility analysis to provide the height and location of nearby features with a required level of accuracy.

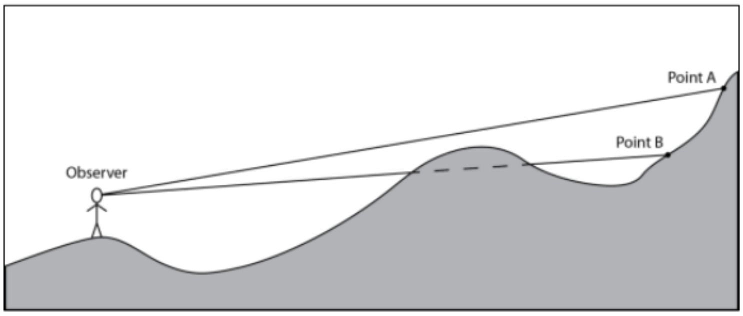


Fig 5.Visibility analysis. Point A is visible while Point B is not

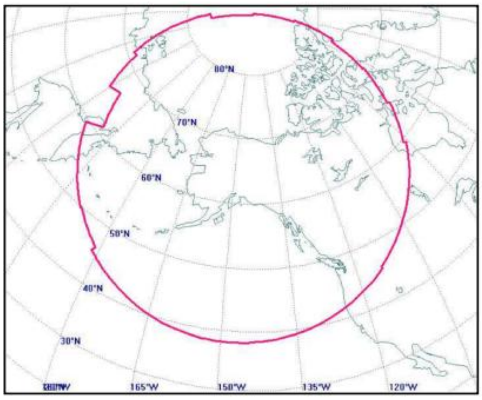


Fig 6.An example of a reception mask of ground station [2].

The visibility mask analysis shall differ from location to location and be driven by the nearby objects and the minimum elevation of the antenna to be used. In ideal conditions, 5 degrees of elevation is used to evaluate the visibility mask. But if the antenna is located in a mountainous area, the elevation should be higher and must be considerably taken in to account to assess the system's performance and operation.

### 3.3 Site conditions

Site conditions for aremote sensing ground station are all the issues needed to be examined and evaluated for a selected area. These conditions include both technical and administrative criteria such as: geology, weather, horizon conditions, air traffic and aircraft protection, land ownership and commitments by local authorities.

In order to have a reliable analysis and assessment, relevant data and information shall be collected for the selected site. The data may be from 10 year record of meteology or geology to evaluate the impact of land foundation or natural hazards such as earthquake, typhoon and whirlwind. [3]


Fig 7. An example of a site survey done in Ho Chi Minh City, Vietnam [3]

Other issues should also be considered:

- Site accessibility
- Local infrastructure and accommodations
- Electrical power
- Technical and personnel support,
- Site security and safety

## IV. CONCLUSION

Scientific basics for planning activities of remote sensing ground station network in Vietnam have been done based on existing situation and future need. These are preliminary results providing reliable inputs for space agency leaders who are working on selection and approval of remote sensing ground station and for ground station owners who are operating the system in an efficient manner and optimize the agencies' resources and national benefits.

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