THE EVOLUTION OF GISTDA SATELLITE CONTROL CENTER

Wasanchai Vongsantivanich (wasanchaiv@gistda.or.th), Ravit Sachasiri (ravit@eoc.gistda.or.th), Pornthep Navakitkanok (pornthep@eoc.gistda.or.th), Jayranon Plaidoung (jayranon@eoc.gistda.or.th), Dumrongrit Niammuad (d.niammuad@eoc.gistda.or.th), Poom Popattanachai (popat.pm@eoc.gistda.or.th)

GISTDA Siracha Ground Control Station, 88 M.9, Thung-Sukla, Siracha, Chonburi 20230, Thailand

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ABSTRACT

Since the launch of THAICHOTE (THEOS) on 1st October 2008, GISTDA has gained several years of invaluable experience in remote sensing satellite operation. At the beginning of the mission, all of the operations depended mainly on the ground control systems and knowledge provided by Astrium, the satellite manufacturer. After GISTDA had familiarized with the operations and maintenance procedures during the early mission, several limitations were observed.

From these reasons, GISTDA initiated several projects to develop its own capabilities to bring the systems up to date to automate routine activities and ameliorate operation efficiency, more importantly, to be independent and self-sufficient. Until now, GISTDA has developed its own state of the art tools for the whole remote sensing satellite operation chain. This paper gives an overview and the history of the development of GISTDA's satellite operation programs.

Currently, these tools are being developed in-house by GISTDA's engineers in cooperation with academics and international partners. The system includes VOSSCA satellite control terminal, EMERALD flight dynamics tool, Mission planning tool, and the THAICHOTE's Image Processing and database system. The development of these programs is the result of GISTDA's quest to be self-sufficient and to lead Thailand and its industry into a space technology proficient country.

1. INTRODUCTION

Remote sensing from space has become a vital tool for earth observation. Space based earth observation system can be separated into three segments, namely; space segment which is the remote sensing satellites, ground segment which includes the ground control station and the application segment, which brings the images/data acquired from space into utilization. This paper focuses on the development of GISTDA's ground segment.

THAICHOTE (previously named THEOS) earth observation system is procured as a complete earth observation system from Astrium in 2005. With this complete packages system, the operators were trained mainly to deal with the routine tasks and daily system maintenance.

At the beginning, the ground system includes the mission planning software, so-called MISEO, which collects the requests and arrange the mission plan to generate daily satellite command. This command is sent to the satellite by satellite control system, OpenCenter, via an S-band antenna. In order to get precise orbit ephemeris for mission planning and orbit maintenance, the software Quartz is used to determine and propagate the ephemeris based on the collected satellite position data (GPS telemetry).

For image segment, after the image data downlink is done, dedicate image processing and data organizing software is in charge of collecting those images into the databases. Raw images corrections and images processing is done only for the manually selected items. The workflow of the satellite operation center, from user's request to user's end product, can be shown in Figure 1.

From years of experiences in remote sensing satellite operations, we are ambitious to develop our own ground control station system. The purpose of this paper is to provide readers the idea of EOS ground operation activities and our plans to develop this system. The details of each system will be given in the following sections.

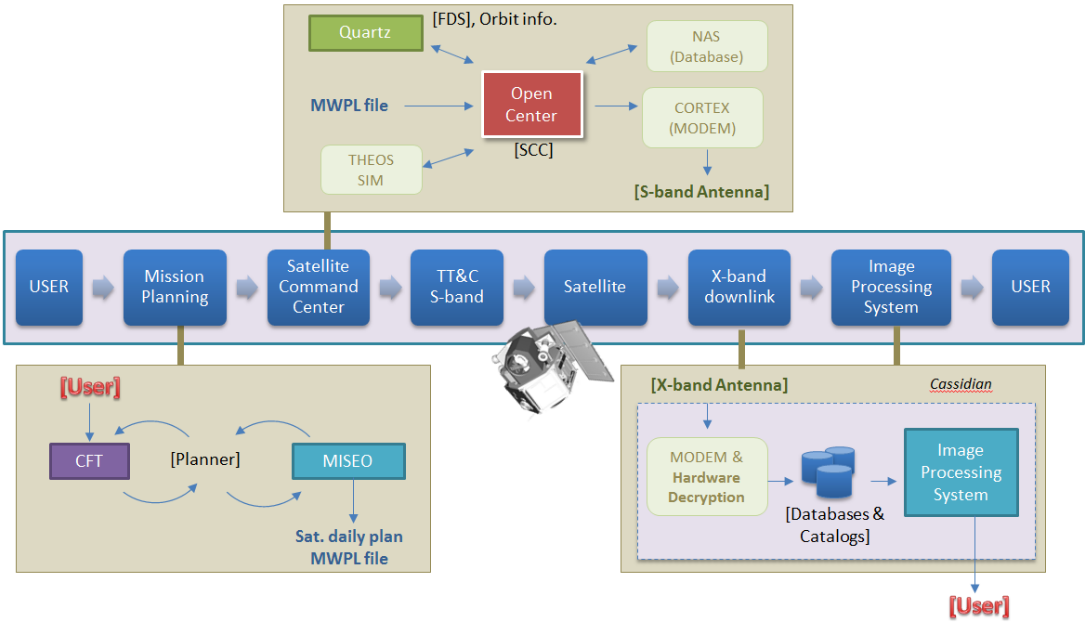

Figure 1: Current workflow for Thaichote ground segment operation.

2. SATELLITE CONTROL CENTER

The function of the Satellite Control Center (SCC) is to be an interface between the control ground station and the satellite, which includes telecommand (TC)/mission plan transmission and telemetry (TM) reception. SCC plays the pivotal role in the satellite operation center since it gathers the commands and information from other systems and then passes them to the satellite.

The new SCC system, VOSSCA (Versatile Operational System for Satellite Control and Administration), is a co-development program between TERMA, Netherlands and GISTDA. The project involves the amelioration of an actual working satellite operation and control software that will be able to replace the Astrium bundle software and can be used with the future satellite missions as well. VOSSCA is applicable to be used as interface software for sub-systems testing during satellite AIV (Assembly-Integration and Validation) phase. It is also capable of handling many types of satellite TT&C protocols, for instance, CCSDS, CAIT, EDEN, PIPE or RPRO.

The software was designed with users (operators) in mind. The routine tasks handling are more robust and more automate with an enhanced user’s interface (QT based). This is done in order to reduce the operator’s workload and ease up the operator’s learning curve. In addition, the operators are able to access the software remotely from anywhere since there is a dedicate API server integrated in the system.

The main advantage of VOSSCA is its capability to handle and perform an immediate TT&C switching between multiple satellites from a single software platform. This is due to the fact that the software recognizes each satellite by its parameters database. Moreover, the software is able to handle with high amount of telemetry points (more than 100,000 TM points) in real-time.

Figure 2: VOSSCA satellite control operator’s screen.

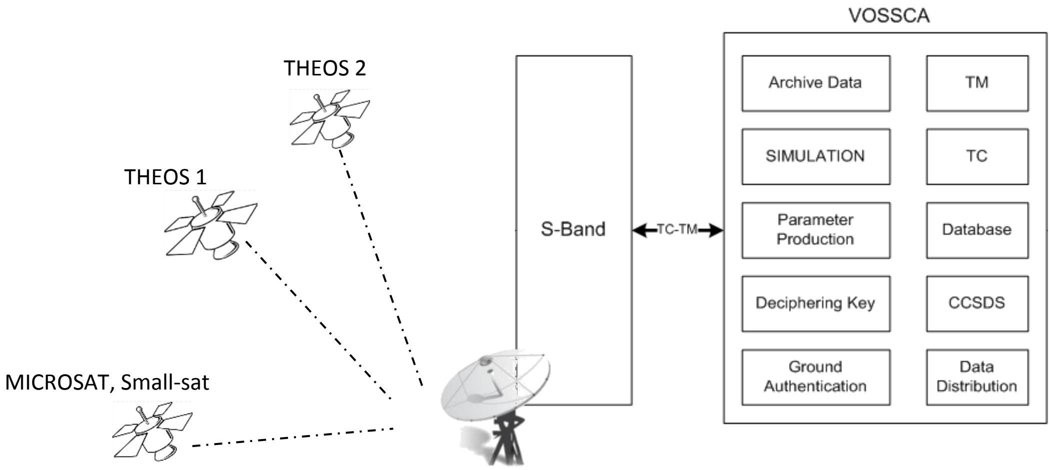

Figure 3: VOSSCA system overview

3. S-BAND SATELLITE ANTENNA

S-BAND antenna can be considered as a part of the SCC, since it is the hardware that is used to transmit/receive the signal to/from the satellite. At present, GISTDA has employed only one S-band antenna station, located in Chonburi, Thailand. In order to have redundancies for TC/TM transmission and to be more self-reliance, the project WATER (Wise Antenna for Transmission Execution and Receiving System) which aims to develop GISTDA's S-band antenna was initiated.

The project is a co-development between NSPO, Taiwan, Thai-German Institute and GISTDA. WATER S-band antenna is a 6-meter antenna with hexapod type platform. The reflector is made as a sandwich structure with carbon-fiber skins over honeycomb core. The platform is capable to track the target up to 6 deg/sec.

Figure 4: WATER antenna, its reflector, and its platform.

4. FLIGHT DYNAMICS TOOL

The precise forward projection of the orbit ephemeris for EOS satellite has a direct effect on image acquisition planning and scheduling, since this information is important for calculating an accurate image acquisition plan. Also, for the operations, the flight dynamics system has to ensure that the satellite is in the right orbit as in the requirement throughout its mission life-time. The project to develop GISTDA's own satellite flight dynamics software, so-called EMERALD has begun in 2013 with cooperation with Mahanakorn University, Thailand.

The EMERALD system consists of three main modules which are the routine module (orbit determination tool, orbit propagator, event prediction and the station-keeping manoeuver module). In addition, since space debris has become a critical problem in the present-day space programs, the collision avoidance monitoring tool is also integrated into the system. The details of the computation models use in EMERALD can be found in ref. [1], [5] and [6].

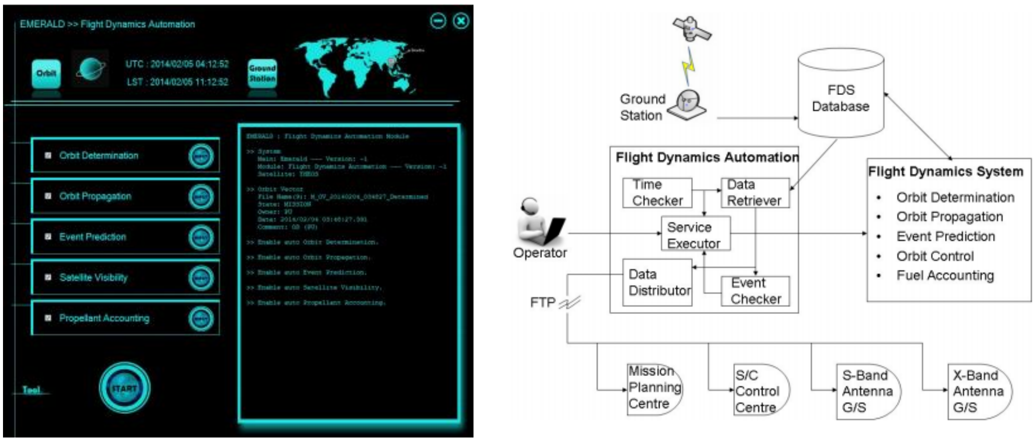

Figure 5: EMERALD graphic user interface, EMERALD operation automation system overview.

5. MISSION PLANNING

Mission planning is one of the most crucial systems in the satellite ground station, because it is the software that manages users' requests in order to generate daily mission plan to be sent to the satellite. For Thaichote mission, two mission planning software are currently deployed in the workflow, which are CFT (Collection Feasibility Tool) and MISEO. CFT is a tool used by user to assess the feasibility of the task before sending the request to the operators. MISEO is used by the mission planning operators to manage and schedule images acquisition. The link of the feasible tasks verified by CFT is loaded to MISEO manually by the mission planning operators. Then the mission plan from CFT has to be verified again in MISEO since there are some discrepancies which could not be modified on the software.

The objective to develop a new mission planning software is to unclutter and simplify this workflow. The overview of the new system is shown in Figure 6. In this project, every module that is necessary for mission planning is integrated in single software platform. The new mission planning tool is also designed by taking into account the scheduled area cloud coverage based on 24 hours in advance global cloud coverage prediction data.

For the planning and scheduling module, the software is designed to be able to manage the optimized plan for multiple EOS satellites as long as the necessary satellite parameters (e.g. payload capability, satellite agility performances) are provided.

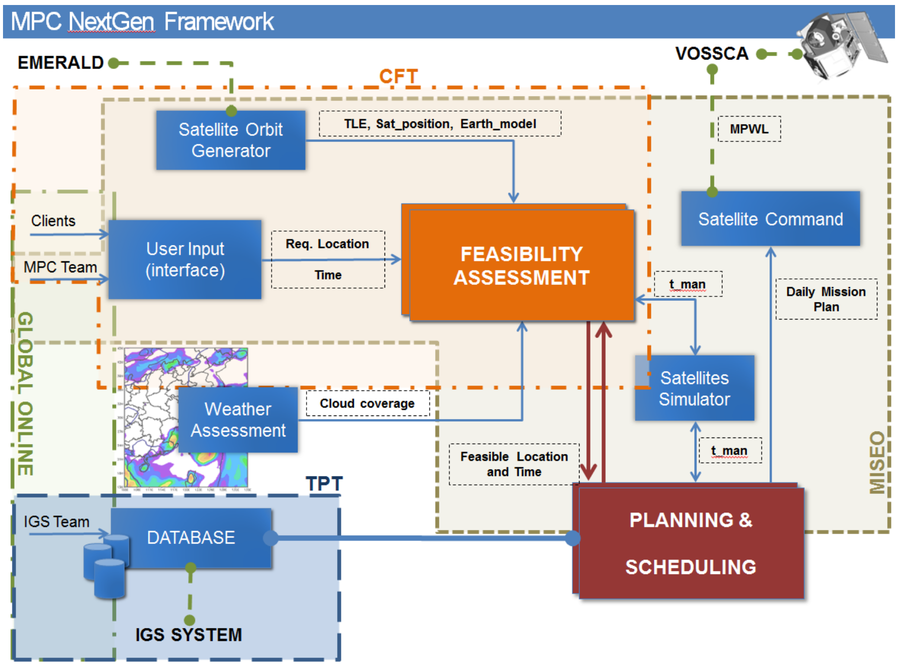

Figure 6: Mission planning software system overview

6. IMAGE GROUND SEGMENT

GISTDA Image Ground Segment can be separated into two main divisions; the satellite data production and archive division and the Satellite data acquisition division. The main mission for the IGS is to acquire THAICHOTE data then archiving and to generate the standard products to users.

GISTDA operates two ground receiving stations in which one acts as nominal site and another as redundant site for most of the operation. Other than Thaichote which is our own satellite, GISTDA also work with several other EO satellite, either optical or SAR. Currently, GISTDA IGS has initiated a plan to develop our own Optical Image Processing System and this system will be deployed instead of the current licensed system. This will also open up the paths for further development of the IGS system and develop a more complete framework in future satellite operations.

7. CONCLUSION

By integrating all of the sub-systems as presented in the above sections, GISTDA aims to obtain a complete solution for EOS ground station operation. The objective of these developments is to lead GISTDA to become self-sustained in ground operation activities and to build up the capacity in ground station technology.

Furthermore, since these programs are being developed in-house, the core knowledge is maintained in the agency. This will help in the continuation of satellite technology for Thailand in the long-term. With the current development status, GISTDA envisages the complete self-developed system by the end of 2017.

8. REFERENCES

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