DEVELOPMENT OF NOAA SATELLITES GROUND STATION: A REDUNDANCY SYSTEM

Nawattakorn Kaikeaw[a] Sorawat Chivapreecha[a] Singha Meehuathon[b]

[a]Department of Telecommunication Engineering, Faculty of Engineering,
King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand
Email: nawatakorn@eoc.gistda.or.th, sorawat@telecom.kmitl.ac.th

[b]Geo-Informatics and Space Technology Development Agency,
102 The Government Complex, Building B, Floor 6, Chang Wattana Road, Bangkok 10210, Thailand
Email: singha_m@eoc.gistda.or.th

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ABSTRACT: This paper aims to introduce a redundant system for NOAA in the Automatic Picture Transmission (APT) mode at the Thailand Ground Receiving Station. The Geo-Informatics and Space Technology Development Agency (GISTDA) has the capability to downlink NOAA satellites data in High Rate Picture Transmission (HRPT) mode which operates in L-band (1670 – 1710 MHz). However, if this system fails GISTDA is not able to receive any NOAA data. A redundant system is now considered to prevent or reduce the risk of service outage in case of a downlink failure. The proposed redundant system consists of a low cost antenna, a receiver in Automatic Picture Transmission (APT) mode, recording system, decoder software, database system that can be accessed via the internet. The Antenna and receiver in APT mode are operated in the VHF frequency range (137-138 MHz). Therefore, the cost is lower than the receiving system which operates in HRPT mode. The proposed system also includes a recording system and data processing unit in order to process the satellite images by using the freeware decoder software. All archive images can be viewed via catalogue browsing system and stored in a database system on a server where users can have access to these images via the internet. In addition, such a system is very useful as a backup system for downlink NOAA data from the satellites.

1. INTRODUCTION

The Geo-Informatics and Space Technology Development Agency (GISTDA) is the primary government agency with obligation to fulfill the nation needs in geo-informatics. This is to provide Earth Observations data and information. This information can be used in various applications, for instance, the exploration of the natural resources, urban planning, and even in climate change analysis. Currently, both public and private sectors are more perceptive and becoming more aware of this useful information. As a result, there is an essential need to develop and integrate new Remote Sensing (RS) tools to provide such information, especially for RS from space. Therefore, the ground stations located at Latkrabang and Siracha are very important, as they are the crucial elements in capturing the data from satellites, transforming it into useful information and further developing it into a value added data. Unsuccessful capturing of such satellite data could lead to the degradation and failure of the organization which could affect the operation of other agencies.

GISTDA's ground receiving stations have the capability in tracking and down linking the data from various satellites. This includes the weather satellites such as Aqua, Terra and NOAA (15-19). The system which is used to acquire these weather satellites is call MODIS system. In general for NOAA, there are 2 downlink modes which are High Resolution Picture Transmission (HRPT) mode and Automatic Picture Transmission (APT) mode. HRPT is transmitting in L-band (1670-1710 MHz) range and can provide the resolution of 1km per pixel. While APT is transmitting in VHF (137-138 MHz) range and can provide the lower resolution of 4km per pixel.

In the past, GISTDA only used the HRPT mode, but occasionally the downlink was unsuccessful. In order to increase the possibility of capturing the data, the secondary APT mode is now considered as well as the primary HRPT mode. The redundant system in APT mode is developed. The main advantage of this redundant system is an acceptable resolution accomplished with a low implementation cost. This is due to the fact that lower operation frequency tends to lead to lower the cost of the device. Currently, the system implemented supports NOAA-15/18/19 in APT mode.

2. NOAA SATELLITES

The NOAA meteorological satellites are owned by the National Oceanic and Atmospheric Administration (NOAA), United States. There are three versions of these satellites: TIROS, ITOS and Advanced TIROS-N (ATN). The satellites are in the sun synchronous orbit at an altitude around 830-870 km. The scientific payloads include an Advanced Very High Resolution Radiometer (AVHRR), a High Resolution Infrared Radiation Sounder (HIRS), a Stratospheric Sounding Unit (SSU) and a Microwave Sounding Unit (MSU). Data from NOAA in general are being used in clouds study, vegetation and land observation (especially in the area which is covered by snow) and measuring sea surface temperature. In this paper the main payload that the system focuses on is AVHRR. Its details of the characteristic are summarised in Table 1. (Recorded at Tenerife, Canary Islands).

Channel	Spectral Band (μm)	Spatial Resolution at nadir	Applications
1	0.58 – 0.68 (Visible)	1.1 km	General purpose visible for cloud and surface mapping. Biased towards green/yellow and gives very good land detail in the summer.
2	0.725 – 1.00 (Near IR)	1.1 km	Surface water delineation. Biased from red to near infrared. A good general purpose visible sensor that gives surprisingly good land detail even in winter.
3A	1.58 – 1.64 (Near IR)	1.1 km	Cloud / ice discrimination. Can also show good land detail.
3B	3.55 – 3.93 (IR-Window)	1.1 km	Sea surface temperature and night time cloud mapping. Can give extremely accurate temperature readout over a relatively narrow range (-15 to +30ºC). Shows land detail from thermal data.
4	10.3 – 11.3 (IR-Window)	1.1 km	Sea surface mapping and day/night cloud mapping. A good general purpose infrared channel for every day use. Rivers are visible in winter due to their temperature differential.
5	11.5 – 12.5 (IR-Window)	1.1 km	Sea surface mapping, otherwise some what similar to Channel 4.

Table 1: AVHRR3/Channels characteristics.

3. REDANDANT SYSTEM FOR NOAA IN APT MODE

The redundant system for NOAA in APT mode has a reduced resolution of the AVHRR in the HRPT mode by transmitting the two data channels in the range of VHF. These two channels are the visible and infrared as show in Figure 1 (Michael Schoor and Bin Yang., 2008) and Figure 2. (Recorded at Tenerife, Canary Islands).

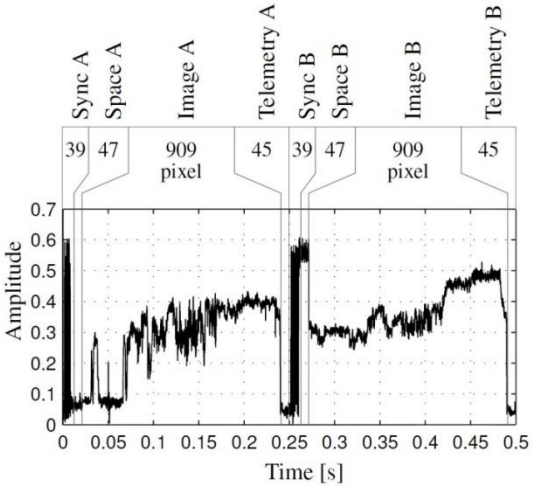


Figure 1: APT Line Format.

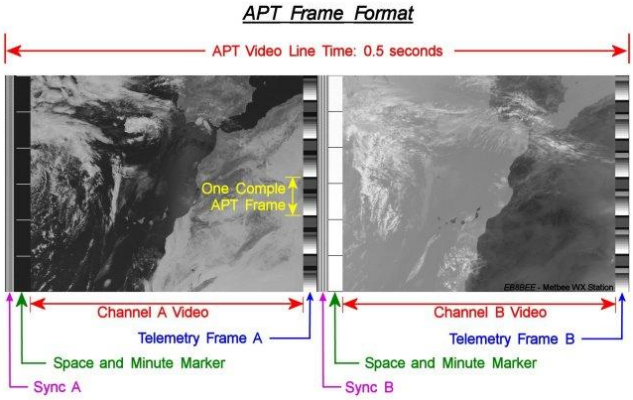


Figure 2: APT Frame Format.

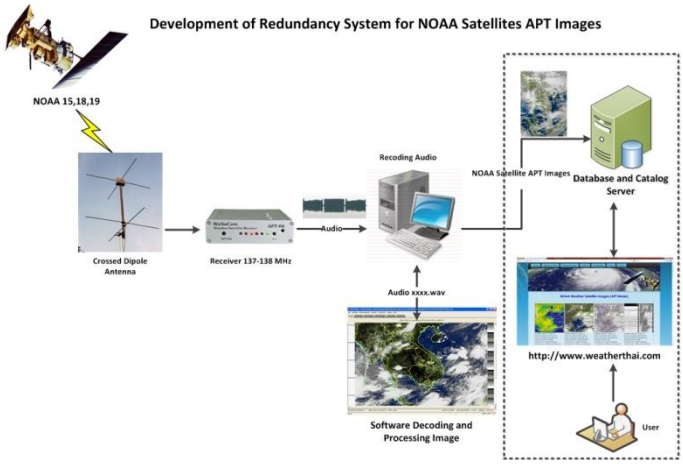


Figure 3: Overall system of NOAA in APT mode.

Figure 3 shows the overall system of NOAA in APT mode. The downlink signal is acquired via the crossed dipole (turnstile) antenna which has a circular polarisation. This type of antenna is simpler and cheaper than a (dish) tracking antenna. It is also possible to replace this antenna with a quadrifilar helix antenna as show in Figure 4 to improve the efficiency. The signal is then passed through a radio receiver in the VHF range (137-138 MHz). This is depending on the satellite, for instance NOAA-15 is 137.62 MHz, NOAA-18 is 137.9125 MHz and NOAA-19 is 137.10 MHz (NOAA Satellites and Information Service., Office of Satellite Operation., 2012). The signal then preformed frequency modulation (FM) with the bandwidth around 30-40 kHz, which is the optimum bandwidth for this frequency. After that the signal transmits to the PC sound card to record it in the WAV format. Then the WXtoImg (Central North Publishing Limited., 2001-2012) or APTDecoder (POES-Weather Ltd Remote Sensing & Software Consulting., 2009) will decode the signal. This software is a freeware which can be downloaded and installed freely. After the decoding step the image can be obtained and stored in the database and can be viewed via the catalogue browsing system as shown in Figure 5, Figure 6 and Figure 7.

Figure 4: Turnstile antenna and Quadrifilar helix antenna.

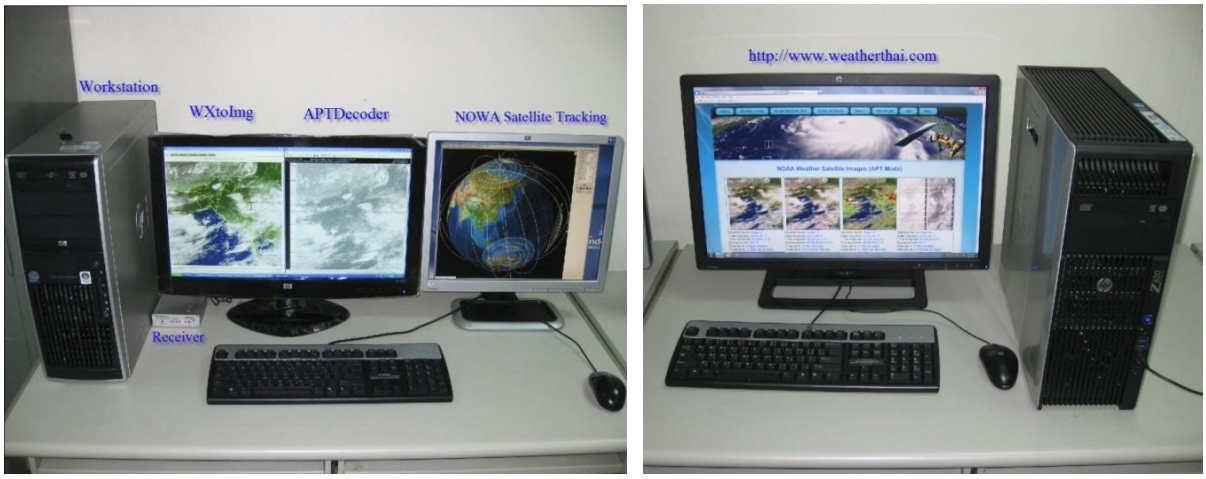


Figure 5: Redundancy system for NOAA in APT mode and catalogue browse system.

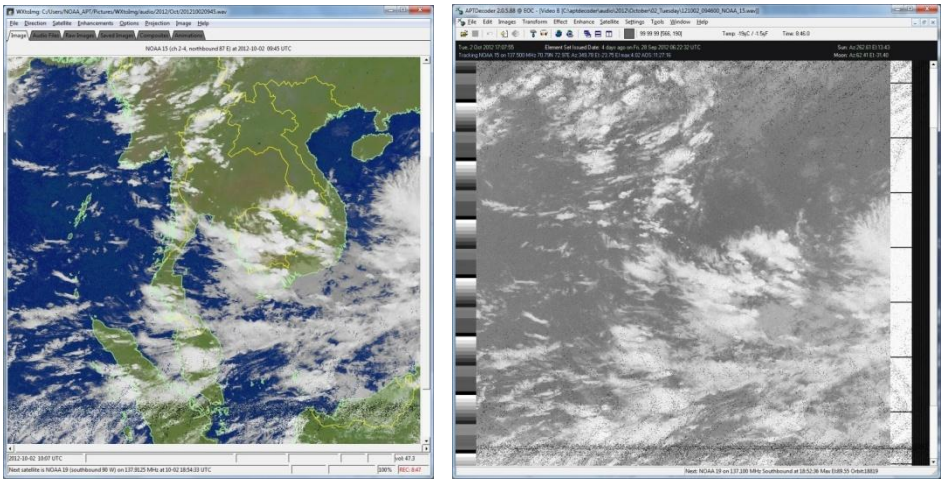
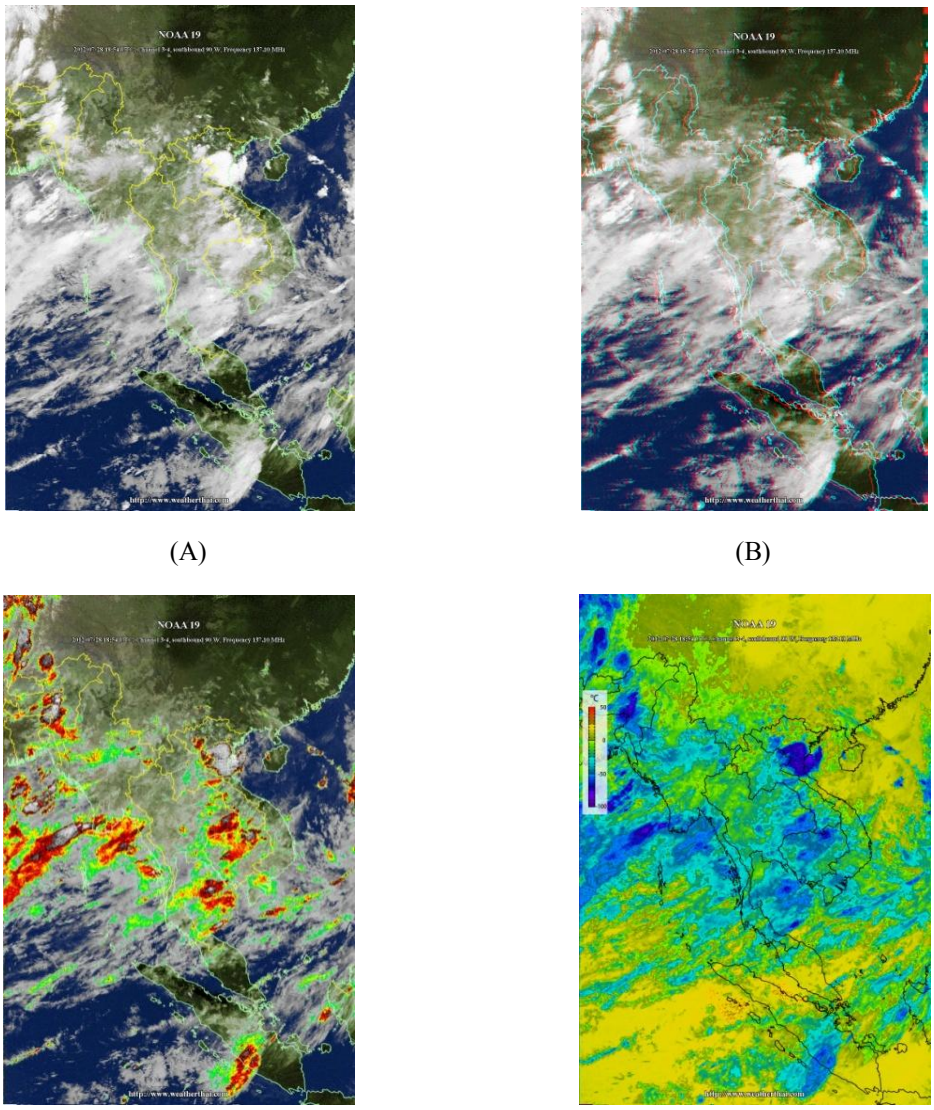


Figure 6: Decoder software: WXtoImg (left); APTDecpoder (right)



(A) (B)

(C) (D)

Figure 7: Sample data from NOAA-19 2012-07-28 1854 UTC.
(A) MCIR (Map Coloured IR); (B) MSA 3D (Multi-Spectral Analysis false 3D);
(C) MCIR (Map Colored IR with Precipitation); (D) Thermal.

4. CATALOGUE BROWSE SYSTEM

The redundant system for NOAA in APT mode includes the catalogue browse system for NOAA-15/18/19 through the web interface at http://www.weatherthai.com as shows in Figure 8 and Figure 9. The aim is to accommodate the search for historic information, weather forecast and for disaster warning support.

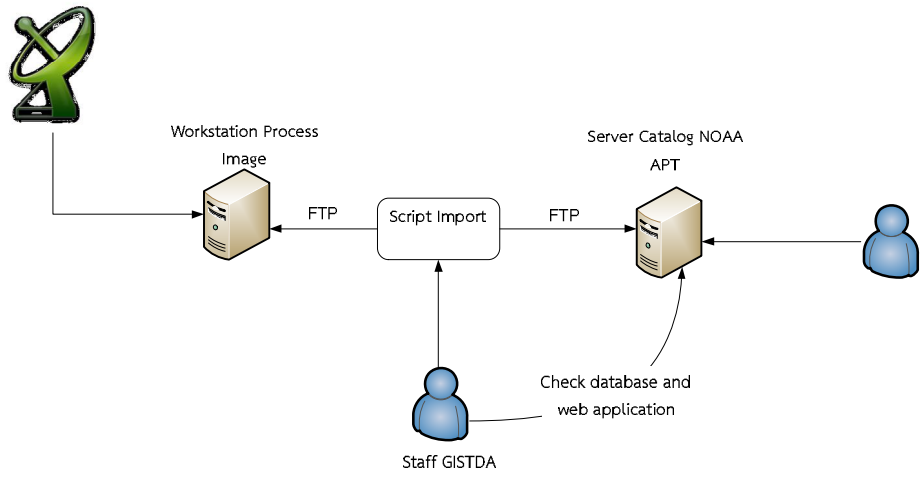


Figure 8: Structure of the system.

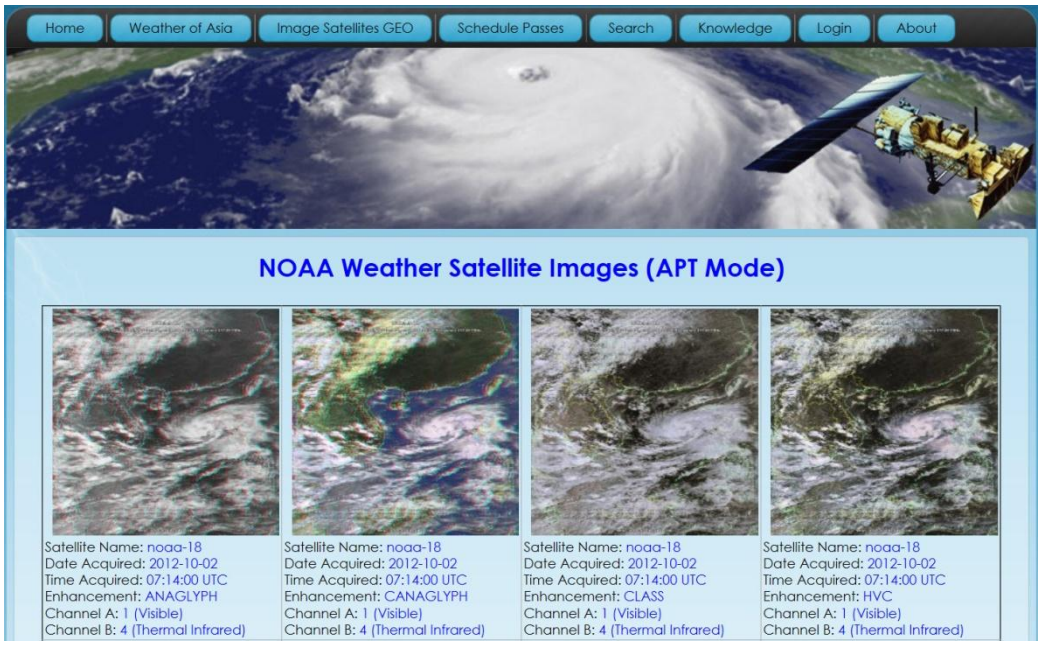


Figure 9: Catalogue browse system at http://www.weatherthai.com

5. CONCLUSIONS

The redundant system for NOAA in APT Mode can be used when the primary HRPT mode is unavailable. The resolution provided from this system is acceptable and the satellite data will be available much quicker. The system is developed at low cost with the user friendly graphic control interface (GUI) and supports urgent response with the quick turnaround time after the acquisition. Users are able to view and search images in APT mode through the website at http://www.weatherthai.com.

6. REFERENCES

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