Acquisition programming integration of image satellites in LAPAN

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Abstract. Acquisition of satellites images programming become an important issue in LAPAN, due to inaccuracy in acquiring image location. Clouds and smokes cause the low quality of the image and also different time acquisition could make a different synoptic view between different sensor. Some integration of three kinds of sensor has to be created for achieving good location with a high quality image. The other reason why the integration needed that because there is still no research about it. This research aim is to get the best acquisition plan by using three different sensors mechanism like SPOT 6/7, Pleiades and Terra SAR-X. This integration also helps Indonesia government in achieving Government National Program.

1. Introduction

LAPAN has been known as satellite imagery distributor especially in Remote Sensing Data and Technology Centre in Pekayon East of Jakarta. SPOT (Satellite Pour l’Observation de la Terre which have meaning Earth observation satellite) constellation is started since 1986, SPOT-1 was the first satellite which launched on February 22nd, 1986. SPOT-2 launched on January 22nd, 1990 and operate until July 2009. SPOT-3 launched on September 26th, 1993 and only operate three years where the satellite has an unstable system in November 1996. SPOT-4 and SPOT-5 are launched on March 24th, 1998 and May 4th, 2002. SPOT-4 operate almost 15 years and its operation ended in June 29th, 2013.

SPOT-4 programming was the predecessor before SPOT-6 and 7 was launched, SPOT-4 programming was simpler than now. The parameter was used are only base to height ratio, cloud cover (quality of the image), the chance of success, coverage method, survey method, incidence angles, date and area of interest. According to some papers that higher the altitude affected the wider of its swath, if the altitude of satellite is not too high than the coverage is not wide as the higher altitude.

The Table 1 explain about SPOT satellite constellation from SPOT-1, -2, -3, -4 and -5. The other explanation is about bands, spectral range and spatial resolution, those parametric evolve every year. The latest technology is acquired by SPOT-5 because SPOT 6 and 7 did not compare in this table. Panchromatic, red, green, blue, Near Infra Red (NIR) and Short Wave Infra Red (SWIR) are available for those constellation. The highest resolution is come from SPOT -5 which have been interpolated from two sensor into 2.5 meter, and the lowest spatial resolution is 1.15 kilometer (SPOT-4 Vegetation). SPOT-1, -2, -3 and -4 are designed without the blue band, but SPOT-3 failed to launch. The color combination only using red, green and infra red, this cause those image only have false...
color not like Landsat 1, 2, 3, 4, 5, 6, 7 and 8. Spatial registration between Panchromatic and red band has been done first for SPOT-4 only, while the other satellite no need any co-registered process. Actually SPOT-5 only have 5 meter spatial resolution in its sensor but after user received then it interpolated into 2.5 until 3 meter spatial resolution.

Table 1. SPOT Constellation SPOT-1, -2, -3, -4 and -5

| Bands   | Spectral range | SPOT-1, -2, -3 | SPOT-4 | SPOT-5 |
|---------|----------------|----------------|--------|--------|
| PA-1 (PAN) | 0.49-0.69 µm | 10 m | 10 m (0.51-0.66 µm co-registered with B2) | 5 m | 2.5-3 m (on-ground) |
| PA-2 (PAN) | 0.49-0.69 µm | 5 m | 5 m | | |
| B0 (Blue)  | 0.43-0.47 µm | Vegetation only (1.15 km at nadir) | | |
| B1 (Green) | 0.49-0.61 µm | 20 m | 20 m | 10 m | |
| B2 (Red)   | 0.61-0.68 µm | 20 m | 10 m | 10 m | |
| B3 (NIR)   | 0.78-0.89 µm | 20 m | 20 m | 10 m | |
| SWIR      | 1.58-1.75 µm | 20 m | 20 m | | |

The next table, Table 2 describe the satellite specification for SPOT-6 and 7. The scene store into 12 bits data quantization. NAOMI (New AstroSat Optical Modular Instrument) instrument is a push-broom imager type which is used by SPOT-6 and -7 Satellite. The spatial resolution of the panchromatic band is range between 1.5 and 2.5 meters and 6 to 10 m for its multispectral band, this condition qualified if the nadir acquisition was achieved. SPOT-6 launched on September 9th, 2012 and SPOT-7 launched on June 30th, 2014, these satellites deployed into the same orbital plane with 180-degree phase.

Table 2. SPOT-6 and -7

| Instrument type | Pushbroom imager |
|-----------------|------------------|
| Optics          | - Korsch telescope in SiC (Silicon Carbide) |
| - Aperture diameter = 200 mm |
| Spectral band (Pan) | 0.45-0.75 µm |
| M5 (Multispectral bands), 4 | Blue: 0.45-0.52 µm |
| - Green: 0.53-0.65 µm |
| - Red: 0.62-0.69 µm |
| - NIR: 0.78-0.89 µm |
| The multispectral bands can be matched to suit customer needs |
| GSD (Ground Sample Distance) | PAN: from 1.5 m to 2.5 m at nadir |
| - MS: from 6 m to 10 m at nadir |
| Detectors | N x silicon area arrays with 7000 pixels PAN, 1750 pixels in each MS band |
| TDI (Time Delay Integration) | The PAN band offers TDI services for SNR improvement of the signal |
| Swath width | - From 10 km to 60 km at nadir depending on GSD and number of detectors S2 |
| FOR (Field of Regard) | ±30° (spacecraft tilting capability about nadir for event monitoring) |
| Data quantization (dynamic range) | 12 bit |
SPOT constellation flies in sun-synchronous orbit type and acquires the image with swath 60 km in width. The altitude of the satellites is 822 km (for SPOT-1,-2,-3,-4 and -5) and 694 km (for SPOT-6 and -7). Mission operator is CNES (for SPOT-1,-2,-3,-4 and -5) and Airbus Defence and Space (for SPOT-6 and -7).

Figure 1. SPOT and Pleiades Constellations

Pleiades 1A is launched on December 17th, 2011 and Pleiades 1B is launched on December 2nd, 2012. Figure 1 describe how those twin satellites flying together in the same orbit with phase 180 degree and along with SPOT constellation. These conditions applies to SPOT and Pleaides satellites, even though each satellite has different time launch they automatically follow programmable orbit. Ground sampling distance (nadir view) is 70 cm on the panchromatic band and 2.8 meters on multispectral but for product resolution its interpolated into 50 cm for panchromatic and 2 meters on multispectral. The swath width is 20 km with an altitude of satellite 694 kilometers. Next figure will visualize how TerraSAR-X and TanDEM-X fly together with altitude 514 kilometers.

Figure 2. TerraSAR-X and TanDEM-X Orbit
Figure 2 display the satellite orbit from two satellites (TerraSAR-X and TanDEM-X orbit). The red and green lines represent orbit for both satellite, the line simulates an elliptical orbit. The color only view the different orbit from each satellite, both lines can be twisted for example red represent TerraSAR-X or vice versa. TerraSAR-X is launched in June 2007 and TanDEM-X is launched in June 2010. They both fly together side by side with helix formation, the distance between them was very close for the flying object it is around 200 -300 meter. Risk of collision is very high for helix orbit with an altitude of 514 kilometers. Single, dual and quadruple polarisation is available to depend on its imaging mode and certain condition. With revisit time along 11 days for acquisition in the same place and orbit inclination in 97.44 degree, those twin SAR satellites prefer to look in the right direction along the track. Next table will be discuss about satellites launching timeline, this timeline has an aim to show the user which one active satellite. It can be seen also the shortest (SPOT-3) and longest timeline (SPOT-2).

**Table 3. Satellites Timeline**

| Year | SPOT-1 | SPOT-2 | SPOT-3 | SPOT-4 | SPOT-5 | SPOT-6 | SPOT-7 | Pleiades 1A | Pleiades 1B | TerraSAR-X | TanDEM-X |
|------|--------|--------|--------|--------|--------|--------|--------|------------|------------|------------|----------|
| 2014 |        |        |        |        |        |        |        |             |             |            |          |
| 2015 |        |        |        |        |        |        |        |             |             |            |          |
| 2016 |        |        |        |        |        |        |        |             |             |            |          |
| 2017 |        |        |        |        |        |        |        |             |             |            |          |
| 2018 |        |        |        |        |        |        |        |             |             |            |          |
| 2019 |        |        |        |        |        |        |        |             |             |            |          |
| 2020 |        |        |        |        |        |        |        |             |             |            |          |

This table 3 shows that since 2014 from now there are 6 active satellites which can be ordered through programming request. In the future, those six satellites will be integrated into one system or platform that can be managed to achieve optimization result.

### 1.1. Literature Review

The literature started with topic acquisition programming integration between Optic and Radar Constellation. Literature study for the mechanism, procedure, and programming on image satellites, in this case like Optical and Radar imagery. Literature research also covers the satellite orbit definition and how to integrate several image satellites programming in one system. For optic imagery, they are several types of the satellite but it is limited into a high-resolution image. Those high spatial resolution image like SPOT-6 and -7 also Pleiades 1A and 1B. Radar constellation only limited to TerraSAR-X only. Searching also focused on incidence angle and cloud cover term because these terms become major issues for differentiating optic and radar constellation. Radar did not require cloud cover parameter where the optic sensor is dependant to clouds and solar lights. Incidence angle applies for both sensor but the value is set different, the radar of SAR sensor need side looking imaging but optic need vertical imaging (called nadir). Processor gain attenuator is very crucial to the radar constellation but optic does not have an effect too much. Study on predecessor satellite-like SPOT-1,-2,-3,-4 and -5 were regarded important. High spatial resolution change since SPOT-5 was 10 meter become 2.5 meters were a very revolutionary choice. Now the SPOT-6, -7 and Pleiades were having a very high
spatial resolution, the blue band also added since SPOT-6 was assembled. Mostly user guide on one access portal, TerraSAR-X, SPOT, and the Pleiades was cited in this research.

1.2. Aims

This research purpose is to ensure the availability of optimal and efficient studies of integration from high-resolution imagery, very high-resolution imagery and Synthetic Aperture Radar imagery programming. Also to improve the optimization and operational effectiveness of multi-mission programming stations (the use of the credit, programming level and request time).

1.3. Methodology

Literature study for the mechanism, procedure, and programming on image satellites, in this case like Optical and Radar imagery. Optical data like SPOT-6, SPOT-7, Pleiades 1A, and Pleiades 1B. Literature research also covers the satellite orbit definition and how to integrate several image satellites programming in one system.

1.4. Concepts and Definition

Most of the scientific satellites usually located in a low earth orbit, six of these satellites also in low earth orbit. These three types of Earth orbit: high, medium and low earth orbit. High earth orbit flies in altitude of 35,780 km above the earth while medium earth orbit has altitude range from 2,000 to 35,780 km. Low earth orbit has a range of altitude between 180 and 2000 km. Those four satellites travel inside Sun-Synchronous orbit, this orbit has a constant angle value for orbit space, thus provide consistent brightness to the satellite. This orbit gives benefit to the earth observation satellite because it is always receiving constant sun illumination. The other orbit like Polar is inclined approximately 90 degrees to equatorial space, this inclination can cover north and south pole area. Incidence Angle is the angle between ground normal and looks direction from satellite, in the next figure the incidence angle represented as $\beta$. SPOT 6/7 have ranged in incidence angle from 0-55 degree, and for Pleiades, the range is from 0-33.6 degree. Viewing Angle (which is represented as $\alpha$) is the angle between look directly from the satellite and nadir. Look direction angle from the satellite may be projected onto two planes defined in the local orbital frame: (yaw axis, pitch axis) and (yaw axis, roll axis).

![Figure 3](image)

**Figure 3.** Relation between incidence angle, viewing angle, height satellite and earth radius

Figure 3 can shown a better understanding in calculation of Ground sampling distance (GSD). GSD is the distance at ground view by two consecutive pixels (in meters) along with both directions: line and
column direction of an image. Those parameters can be visualize easier than without geometric visualization.

\[
GSD = h_{sat} \cdot \tan(\alpha + IFOV) - h_{sat} \cdot \tan(\alpha)
\]

\[
GSD_c = R_E \cdot \left[ \frac{\left(1 + \frac{h_{sat}}{R_E}\right) \cdot \cos(\alpha)}{\left(1 - \left(1 + \frac{h_{sat}}{R_E}\right) \cdot \cos(\alpha)\right)^{1/2}} - 1 \right] \cdot IFOV
\]

where

\[
h_{sat} = 695 \text{ km}
\]

IFOV for panchromatic (rad) = 1.00E-06 and multispectral (rad) = 4.00E-06. The earth regarded as ellipsoid will have two axes which are semi-major axis (6378.14 km) and semi-minor axis (6356.75 km). The radius of earth represented by R_E, the value of radius is approximately 6367.45 km in average.

**Table 4.** Calculation of GSD PAN and MS

| Global viewing angle (°) | PAN GSD (m) | MS GSD (m) | IMAGERY depth width. | PAN GSD (m) | MS GSD (m) | IMAGERY depth width. | GSD (%) | Error (%) |
|--------------------------|-------------|------------|----------------------|-------------|------------|----------------------|---------|-----------|
| 0                        | 20.0        | 20.0       | 20.0                 | 20.0        | 20.0       | 20.0                 | -       | -         |
| 10                       | 20.0        | 20.0       | 20.0                 | 20.0        | 20.0       | 20.0                 | -       | -         |
| 15                       | 20.0        | 20.0       | 20.0                 | 20.0        | 20.0       | 20.0                 | -       | -         |
| 20                       | 20.0        | 20.0       | 20.0                 | 20.0        | 20.0       | 20.0                 | -       | -         |
| 25                       | 20.0        | 20.0       | 20.0                 | 20.0        | 20.0       | 20.0                 | -       | -         |
| 30                       | 20.0        | 20.0       | 20.0                 | 20.0        | 20.0       | 20.0                 | -       | -         |
| 35                       | 20.0        | 20.0       | 20.0                 | 20.0        | 20.0       | 20.0                 | -       | -         |
| 40                       | 20.0        | 20.0       | 20.0                 | 20.0        | 20.0       | 20.0                 | -       | -         |
| 45                       | 20.0        | 20.0       | 20.0                 | 20.0        | 20.0       | 20.0                 | -       | -         |
| 50                       | 20.0        | 20.0       | 20.0                 | 20.0        | 20.0       | 20.0                 | -       | -         |

Table 4 show the result from GSD calculation for several numbers input of global viewing angle (\(\alpha\)).

It can be concluded that the higher global viewing angle then the GSD error also have higher number.

### 2. Programming Acquisition Comparison

In this part it will be filled some mechanism, procedure and programming of several types of satellites like SPOT-4 in several years behind and comparing to SPOT 6 or 7 also for radar programming (TerraSAR-X).

**2.1. SPOT-2, and -4**

SPOT-4 example was taken on this programming request, Sirius portal and software were used to order SPOT-4 and SPOt-2 image. Proposed images were chosen based on several circumstance and consideration, for example, if the image has high cloud cover but clear for some area, thin haze, perfect incidence angle and another thing. Next figure is the graphical user interface of the Sirius portal.
Figure 4. GUI of Sirius Portal and Catalogue

Figure 4 display a portal and web catalogue of SPOt-4 where Karawang region was chosen for ordering SPOT-4. The specific area can be seen through an area of interest with a red line and the available SPOT-4 image represented by the green line of the image footprint.

Figure 5. SPOT Programming Proposal Request

Figure 5 display sample of programming request, programming request for SPOT-4 was operationally managed by CNES, the website portal is Sirius spot image. This French programming request can be set the parameter configuration like programming service (standard or priority), acquisition period (multi or single), coverage method (monoscopic or stereo), incidence angle between west 31.06 degree and east direction 31.06 degree, clouds with shadow (percentage measurements), snow with ice (percentage) and others. The area of interest created based on Scalable Vector Graphics (SVG) XML vector format file. Those parameters determine the chances of success (value will be low, medium and
good) for image acquisition program. The product types of SPOT-2 and -4 are SPOT-2 Level-1A, Level-1B, Level-2A, and Level-2B, other levels were not produced more than those levels.

2.2. Pleiades 1A, Pleiades 1B, SPOT-6 and SPOT-7

Programming Pleiades 1A and 1B similar to SPOT-6 and -7 and this programming only described on the Pleiades. Table 5 show the list of proposed acquiring strips for Kukar region (Pemkab Kukar) where incidence angle and cloud cover are shown. Combined, roll and pitch angle also showed here, the quick look can be directly referred from the link to help visualize the image display.

| ICR_FG_226091 - Pemkab Kukar | Acquired Strip ID | Satellite | Date     | Incidence angle | Cloud Cover | Status |
|-------------------------------|------------------|-----------|----------|-----------------|-------------|--------|
| A8_FC_226091_1_2             | PHR1A            | 2019-02-24 | 25°59'   | 18°19'          | 2.0%        | Proposed |
| A5_FC_226091_1_3             | PHR1A            | 2019-02-24 | 24°59'   | 18°19'          | 17.6%       | Proposed |
| A3_FC_226091_1_5             | PHR1A            | 2019-02-24 | 24°59'   | 18°19'          | 17.6%       | Proposed |
| A6_FC_226091_1_7             | PHR1A            | 2019-02-24 | 24°59'   | 18°19'          | 27.0%       | Proposed |

Table 5. ICR List Table of Programming Request

This table show the list of ICR with number 226091 where Pemkab Kukar is selected for programming request. Four data have status with proposed, there are other status like valifaedm rejected, refused and out of specification. Those status created according to certain criteria. Inside one access portal, the Pleiades can be ordered with certain parameters, those parameters like programming level (standard, priority and urgent), acquisition method (mono, stereo, and tri-stereo), Incidence angle (represented positive and negative real number) and validity date. For operational programming, the default of base to height ratio is set by system default 0 to 1 but according to the Pleiades user guide, the number will be various. For example, base to height ratio standard values are 0.4 to 0.7 for stereo and 0.2 to 0.35 in each pair of tri-stereo image. Optimum base over height ratio really depends on image relief. The explanation detail will continue into the next chapter (Chapter 3. One Access Portal).

2.3. TerraSAR-X

The programming can query an order and image database based on certain criteria like sensor mode, polarisation, acquisition range, looking and path direction, range of incidence angle. TerraSAR-X products can be divided into two product groups, those groups are basic and enhanced image product. The basic product image or Level 1-B product group have consisted of EEC (Enhance Ellipsoid Corrected), Single Look Slant Range Complex (SSC), Multi-look Ground Range Detection (MGD) and Geo-coded Ellipsoid Corrected (GEC). While the enhanced image product group are ortho-rectified, radiometrically corrected, mosaic and ascending or descending mode. The standard cartographic projection for TerraSAR-X product is Universal Transversal Mercator (UTM) and Uniform Polar Stereographic (UPS) with WGS 84 Ellipsoid.
Figure 6. GUI of TerraSAR-X criteria for query

Figure 6 show some input parameter for radar programming request, it can be seen that different parameter determined compared to SPOT or Pleiades. Processor gain attenuation parameter has an impact on the scaling process, for example, if the parameter set to 0 dB then it is suitable for the military purpose where shadows of low values are of interest. If the image was analyzed for an urban mapping detection then it will require many high returns where the value of 10 dB. TerraSAR-X product is available in 16-bit integer values, sometimes very bright target (like corner object) exceed 16-bit data range. A value scaling is required to delete those high value on a very bright object, the processor gain attenuation will increase or decrease the radiometric contrast. Terra SAR product order can be set under user requirement like processing level (for example L1B), product type (EEC, GEC, SSC, MGD), orbit precision, processing priority, projection, customer acquisition priority, processor gain attenuation and other.

3. One Access Portal

One access portal (OAP) is a system that integrates all airbus product like SPOT-6/7, Pleiades-1A/1B, and TerraSAR-X (and TanDEM-X). This system can be used for ordering images by handling certain parameters, it also can visualize orbit pass of each satellite. Report on successful image acquisition can be obtained through the portal on the web format.

3.1. Interface

The graphic user interface from one access portal can be view by accessing the web page address https://www.intelligence-airbusds.com/, here is the figure look-alike. After login with the username and password, the web page will automatically refer to the tasking cockpit on Airbus desktop.
Figure 7.1 GUI of One Access Portal and Catalogue

Figure 7.1 display the design of one access portal web which is containing airbus programming request for Pleiades and SPOT. Hompage login is in the left of the figure and for the right side is the list of image request database. This list also show some map service with area of interest from user or program.

3.2. ICR and Programming Request

Imagery Customer Request (ICR) is the name of order identification, request programming for Pemalang Regency Center of Java Province (ICR number 227412) can be seen in the next figure. The next figure is displayed several scenes of Pleiades quick look where it is overlaid with the area of interest, there also exist a list of several acquiring strips.

Figure 7.2. GUI of Sample ICR No.227142

Figure 7.2 show how the data has been selected and viewed in the webmap portal. ICR example is ICR_FC_227412 Satellite orbit information can be drawn through this web map, it can be chosen of its satellite sensor types, date range, area, roll angle value, and another parameter. There are three levels of acquisition programming, the level standard, priority and urgent.
Figure 8.1 GUI of Satellite Orbit (Pleiades orbit) as one of feature from One Access Portal

Figure 8.1 show all of orbits that covered by Pleiades satellite, where the list of database is also displayed in the left pane. Next figure will show some detailed orbits if someone select one of the orbit from the database.

Figure 8.2 Detailed orbit

Figure 8.2 visualize some function which provides satellite acquisition on daily basis, time acquisition can be acquired by selecting the suitable sensor satellite. It can be seen from the figure that how Pleiades and SPOT acquire an image on specific location and time accurately. Acquisition and download task also represented in unique symbol.
4. Optimization Parameters

Each parameter from programming acquisition input has an important role in making the high quality of image, the result of optimization has to be combined from several parameters or constraints. For example like the base to height ratio, cloud cover, incidence angle, area of interest and others.

4.1. Stereo (Base to Height Ratio)

In aerial photography base height ratio is defined as "the distance on the ground between the centers of overlapping photos, divided by aircraft altitude".

![Figure 9. Illustration of B/H Ratio](image)

From the figure 9, it can be concluded that a higher ratio of the base over height will not cover an object in the valley which is located between two mountains. The baseline is actually created by a distance between two locations of the different satellite (or same satellite but in the different acquisition of timing). The height that defined here is the distance between perpendicular baseline into earth surface or the altitude of the satellite.

4.2. Cloud Cover

Cloud cover is the coverage of valuable clouds present in satellite imagery which are usually described as indexes, percentages, scores, etc. For SPOT-4 and SPOT-2 it is usually represented by a score like (AAAAB) but the values are different for SPOT-6 and SPOT-7. The percentage represented from 0-100 percent if 0 percent cloud cover then the display will be a clear picture. Thin fog, gloomy pictures (cirrus or Columbus nimbus), smoke (caused by fire) and acquisition of errors can be one of the factors that cause the quality of cloud cover. This parameter is not required for TerraSAR-X programming requests.

4.3. Area of Interest

Area of Interest is an area created by the user to select imageries which intersect with the user creation shape. The shape coordinate can be determined by the user through the web (on the fly) and uploading from an internal computer. According to SPOT 6 user guide that AOI is "An AOI outlines a particular region by panel, shape, preset values, or by a defined line and sample". Area of interest is based on a user request for example mountain area, hilly, lake, sea, the forest is a different object which determines the request. Disaster usually locates the AOI randomly, but for the monitoring like forest, mangrove, peat-land, paddy field monitoring are repeating the request with the same AOI.
4.4. Incidence Angle

Incident angle for SPOT-6 and -7 range between 0-55 degree and for the Pleiades ranging from 0 until 33.6 degrees. But for ordering Pleiades or SPOT the range will be limited from 0 - 30 degree. Incident angle for TerraSAR-X ranging from 15 until 60 degrees but for best performance of the quality image the range will be display on the next table. The incident angle on Radar Constellation will various and it depend on imaging mode and polarization mode.

Table 6. Recommended Performance Beams and Incidence Angle Ranges for High Contrast Scenes

| Mode        | Pol Mode | High Contrast Recommended Performance Beams (Criteria Rg -25 dB Az -20 dB) | Incidence Angle (Look Angle) Ranges |
|-------------|----------|---------------------------------------------------------------------------|-------------------------------------|
| Stripmap    | Single   | strip_003 - strip_014                                                     | 19.7° - 45.5°                       |
| Stripmap    | Dual     | stripNear_003 - stripFar_011                                              | 19.9° - 40.3°                       |
| SL & HS     | Single   | spot_010 - spot_079                                                       | 19.7° - 49.7°                       |
| SL & HS     | Dual     | spot_010 - spot_059                                                       | 19.7° - 43.3°                       |
| ST          | Single   | spot_034 - spot_067                                                       | 32° - 45°                           |
| ScanSAR     | Single   | scan_003 - scan_011                                                       | 19.7° - 45.5°                       |

Table 6 is explain about range value of incidence angle or look angle for every radar mode of acquisition and also its polarization mode. Zero value on incidence angle is the perfect or best acquisition from the optic sensor, the incidence angle approach zero will benefit to nadir view imaging. But this zero’s incidence is not also applied to the radar sensor, because all energy that transmits from the radar sensor to the object in the ground will perfectly reflect back to the sensor. This condition makes reflection was accumulated and the intensity becomes high, the resulting image will bright in all area.

4.5. Date Acquisition

The time range is an important parameter to support the chance rate success result. If the range is too short then it will produce failure result and if a long period was chosen then it will provide an error result. This basic and primary parameter is an important key to the programming request, mission plan of image acquisition.

5. Credit Accounting

The provider gives some concept in calculating the requested order (acquisition amount/unit) which are different for every sensor. In this part, there will be some understanding of how a user can calculate how much order or amount that can be acquired. One credit is equal to one "ES" or called Equivalent Scene, limitation of one-year consumption will be maximum to 3000 credits. The contract between SPOT and Pleiades will be differentiated, for SPOT there will no credit account. Unlimited consumption on SPOT Constellation or open access but only limited to priority and urgent request programming for 100 in number annually. Pleiades programming request will be limited to 3000 credit where 1 credit equal to 1 equivalent scene (called "ES").

5.1. Pleiades

Pleiades image has 400 km square area from 20 km (relative upon its incidence angle) for each side. For 20 km in length Pleiades sensor require 3.125 seconds to accomplish its acquisition
Figure 10 display how credit consumption calculated for one equivalent scene, those apply for SPOT and Pleiades.

5.2. **SPOT**

SPOT-6/7 sensor has a length and width 60 km for each side, and it means nearly 3,600 km square for its area which is equal to one credit. From the last figure, it is shown that Pleiades need 0.99 ES to establish one mesh but for the SPOT it only requires 0.94 ES. The SPOT images are not limited for acquiring the data, the ES credit calculation did not affect much for SPOT programming request this year.

5.3. **TerraSAR-X**

Credit calculation on TerraSAR-X is different from SPOT and Pleiades Constellation because there are several imaging modes. Wide ScanSAR, ScanSAR, Strip Map, Spot Light and High-Resolution Spot Light, there are can be 1500 square kilometer equivalent. For example Strip Map (3m) square kilometer scene size is 30 km in width multiply with 50 km in length which is equal to 1500 kilometer square. But if the example for Wide ScanSAR (40m) the length 270 km multiply with 200 km then the result is 54000-kilometer square which is not equal to 1500 km2. The value 54,000 km2 will be equivalent to 1,500 km2 from Strip Map, the equivalence will be displayed in the next table.
Table 7. TerraSAR-X Credit Accounting

| TerraSAR-X Credit accounting | Unit          | Number of credit(s) | Sq.km Acquired (Sensor size) | Sq.km Equivalent* |
|-----------------------------|---------------|---------------------|-----------------------------|-------------------|
| Wide ScanSAR 40m            | 1 acquisition | 1                   | 270x200                     | 1 500             |
| ScanSAR 18m                 | 1 acquisition | 1                   | 100x150                     | 1 500             |
| StripMap 3m                 | 1 acquisition | 1                   | 30x50                       | 1 500             |
| SpotLight 2m                | 1 acquisition | 1                   | 10x10                       | 1 500             |
| Starlight Spotlight 0.25m   | 1 acquisition | 1                   | 4x3.7 or 2.5 x7.5           | 1 500             |
| HiRes Spotlight (HS and HS300) | 1 acquisition | 1                   | 10x5                        | 1 500             |

Table 7 can conclude that square kilometer which acquired by scene size will change for every 600 credit value. For example, if all credit utilized only for wide ScanSAR then 600 credit units multiply with 270x200 will equal to 32,400,000 kilometer square. Compare to all 600 credit apply only to HS SpotLight then the calculation will be 600*10*5 or equal to a 30,000-kilometer square.

6. Conclusion

Optic and radar images are different beside from its sensor, but also for choosing incidence angle, cloud cover. For a radar image, one does not need to set how many clouds cover percentage because radar sensor penetrates clouds and small particle of rains. If incidence angle value in the optic sensor approach to zero then it will have a good image but this condition is opposite to radar. Radar sensor should not equal to zero or even approach to zero because the object will reflect back perfectly, this condition causes high intensity on the image and results to the bright image on all area. That is why the value of radar incidence angle started from non-zero value for example 15 or 17 degrees.

Chance of the programming request result is really determined by that parameter, and if an operator chooses the wrong parameter then the result will be low or completely failed. For example, revisit time parameter can affect date acquisition on a specific location, if TerraSAR-X can acquire an image of Jakarta on January 1st, 2025 and the period of acquiring image set between January 2nd, 2025 until January 9th, 2025 then this will not produce any TerraSAR-X image because the revisit time of TerraSAR-X is 11 days long. On another example like if someone put cloud cover on 0 percentage or zero on incidence angle value of an optic image then the chance of the result will be too low or fail.

From this research exploration that one can see the different procedure and parameter from radar and optic satellite. Those difference hopefully can be integrated into an efficient integrated acquisition programming method. By using consideration of radar and optic parameter acquisition which have been exposed in this research. For example the different of an incidence angle value between radar and optic, it can determine the optimal incidence angle for each sensor.
Acknowledgments

Authors wishing to Allah S.W.T for providing great opportunity, knowledge and blessing while creating this paper. Authors also want to say thanks for Integration of Programming Acquisition team, Remote Sensing Dissemination Division of LAPAN for good cooperation, assistance and encouragement. Thanks also to the Airbus as a provider of One Access Portal.

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