ANTENNA READINESS AND COLLISION SCHEDULE MANAGEMENT ANALYSIS FOR MULTI HIGH-RESOLUTION SATELLITE DATA RECEPTION

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ABSTRACT: Antennas on remote sensing ground station play a very important role in remote sensing satellite data acquisition activities. The LAPAN Parepare Remote Sensing Ground Station (RSGS) has several antennas to receive several types of remote sensing satellite data on a daily basis. Collision analysis on existing remote sensing ground stations is needed to estimate the capabilities and potential conflicts that occur in data reception, especially high-resolution satellite data. From the measurement results, information regarding the ability, potential conflicts, and priority scale of data reception scheduling on the X-band antenna for a minimum of 10 satellites is obtained (for example to receives SPOT-6/7, LANDSAT-7/8, TERRA/AQUA, Suomi-NPP, Pleiades-1A/B, TerraSAR/Tandem-X, JPSS-1, Pleiades Neo, Skysat, WV-Legion, etc) by entering the technical parameters of each satellite, especially the orbital pattern, altitude, constellation and also the time of the satellite trajectory to obtain a conflicting picture and priority of the antenna for receiving data. The satellite data will then be used as recommendations for future high-resolution satellite data reception scenarios, in particular for determining scheduling priorities in receiving high-resolution satellite data in the future if it will be used to receive satellite data for the Pleiades Neo, Skysat and Worldview Legion constellation satellites on remote sensing ground stations at LAPAN Parepare RSGS.

1. INTRODUCTION

Along with the development of remote sensing data needs in various sectors such as development, health, economy, and various other fields in Indonesia, it must be balanced with an increase in remote sensing ground station technology(Hidayat, Gunawan, et al. 2019). Based on the 2013 Space Law, article 20 states that the Indonesian National Aeronautics and Space Administration (LAPAN) is required to provide satellite image data. LAPAN Remote Sensing Data and Technology Center has 3 ground stations to receive remote sensing satellite image data, i.e. Pekayon RSGS, Rumpin RSGS, and Parepare RSGS(Soleh et al. 2019). Some of these ground stations are needed to obtain the entire image of the Indonesian region because of the geographical location and the wide coverage of the Indonesian territory(Hidayat, Gunawan, et al. 2019). Satellite image data obtained by the LAPAN consists of low, medium, high and very high resolution, and SAR. Utilization of satellite data in the development sector, especially in high and very high resolution, is one of the national priority activities, including Detailed Spatial Planning, Mapping of Industrial Estates, and Territorial Borders. Following Presidential Regulation Number 79 of 2018 concerning national priority programs in the field of regional development directed at development in border areas, village development, agrarian reform, disaster prevention, and management, and acceleration of development, LAPAN has obligations and responsibilities to provide satellite data for the development of detailed maps at a scale of 1: 5000 if the scale can be achieved using very high-resolution satellite data. The large number of high-resolution satellite images received at the Parepare Ground Station causes conflicts during data reception, so it is necessary to have a priority scale for scheduling data reception on the antenna. In this research, we will simulate a ground station to receive remote sensing satellites ranging from low to medium and high resolutions simultaneously.

2. EXISTING CONDITION OF LAPAN'S GROUND STATION SYSTEM INFRASTRUCTURE

The current architecture of the Ground Station system at LAPAN can be seen in Figure 1. below(Hidayat, Suprijanto, et al. 2017). In the remote sensing data center was included remote sensing databank. The remote sensing data bank is supported by 3 ground stations, i.e. Pekayon RSGS, Rumpin RSGS, and Parepare RSGS. Ground station system as the spearhead of the National Remote Sensing Data Bank was located in Pekayon, East Jakarta. All data is stored and sent via the VPN-based internet network(Hidayat et al. 2014). This research will focus to explain the Parepare RSGS, South Sulawesi that performs multi-high satellite data resolution.

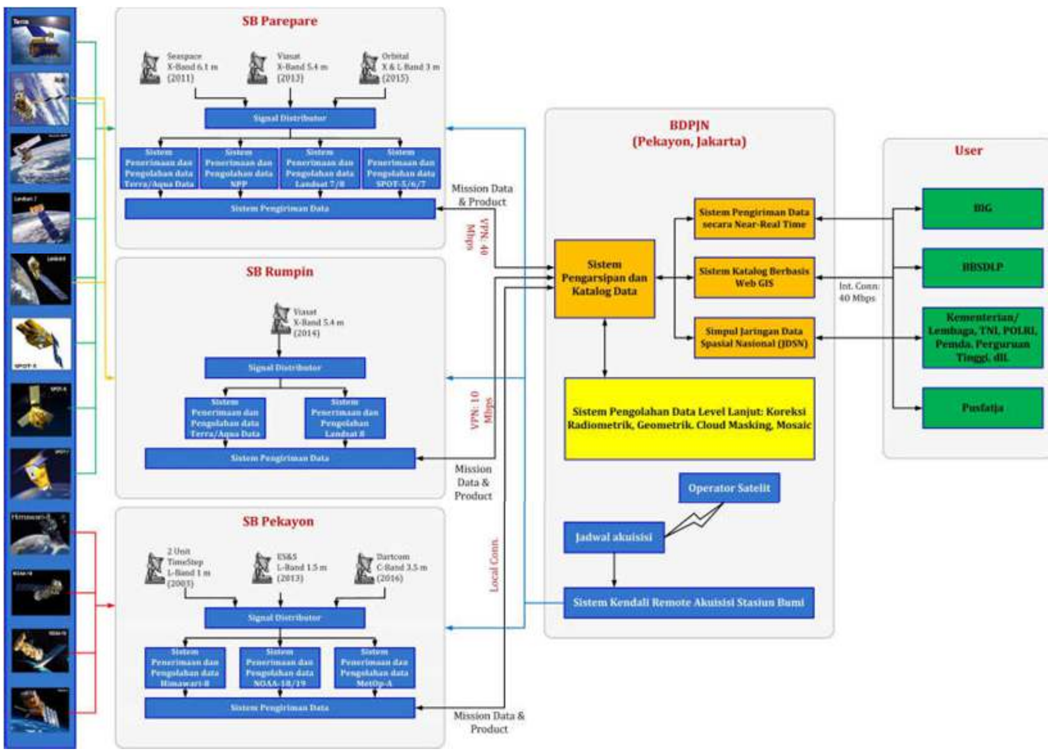


Figure 1.1. The current LAPAN Ground Station system architecture

2.1 Existing Condition of Parepare Ground Station System

Parepare RSGS was established since 1993. Now, Parepare RSGS has three operational antennas for supporting satellite data acquisition. These are the equipments used to support the acquisition, recording, and processing of high, medium, and low-resolution satellite data at the Parepare RSGS here as follows:

a. 5.4 meter Viasat antenna
b. 6.1 Meter Seaspace Antenna
c. 3 Meter Orbital Antenna
d. IF Matrix Switch

e. Zodiac Demodulator
f. Avtec Demodulator
g. Seaspace Demodulator
h. Orbital Demodulator
i. Agilent Spectrum Analyzer
j. MODIS Terra/Aqua and S-NPP Initial Data Processing Systems
k. NOAA-18, NOAA-19, MetOp-A, Fengyun-3a/3B/3C Preliminary Data Processing Systems
l. Landsat-7, Landsat-8 Preliminary Data Processing System
m. SPOT-5/6/7Data Initial Processing System
n. Data Storage System
o. VPN Data Transfer

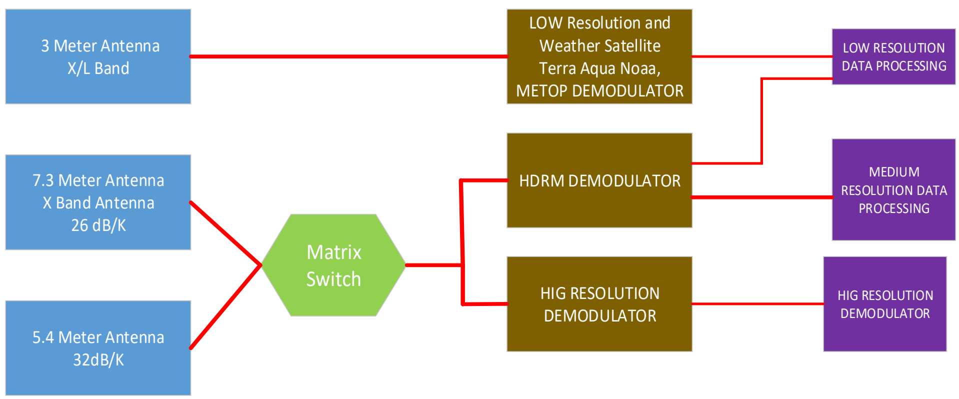


Figure 2.1. Current Parepare RSGS System Architecture

2.1 Antenna System on Parepare RSGS

Parepare RSGS is currently carrying out, acquisition and recording of remote sensing satellite data(Hidayat, Munawar, et al. 2017). To obtain remote sensing data that can cover all parts of Indonesia, we need a location that can cover all parts of Indonesia. In addition, the LAPAN ground station can send data quickly to the data center or data bank in the Remote Sensing Data and Technology Center. In addition, LAPAN Parepare RSGS currently provides services to the public in the form of Remote Sensing Data Services, Regional Information Services based on Remote Sensing Satellite Imagery, Remote Sensing Data Consultation Services, Socialization Services in the Field of Remote Sensing Utilization, and Technical Guidance in the Utilization of Sensing Sector. Parepare RSGS has three operational antennas to receive remote sensing satellite data, i.e. Viasat X-Band Antenna 5.4 m, Zodiac X-Band Antenna 7.3 m and Zodiac Antenna X Band and L Band 3 m. The 5.4 meters antenna has been operating for 8 years since 2012. This antenna is still operating and has good conditions.

2.1.1. Viasat X-Band Antenna 5.4 m

This system features a 16-panel 5.4 meter reflector and high performance autotracking X-band feed. The Y- over X-axis pedestal configuration is mounted on a rigid base extension suitable for ground or rooftop installation(Hidayat, Irawadi, et al. 2019). The dual shaped optics use a monopod feed/subreflector to to optimize efficiency(Sukarta et al. 2016). The result is superior G/T performance.

Lat: -3.977767°LS
Long: 119º 38 '59.65' BT
Altitude: 72 m Antenna System
X Band 8.025 - 8.5 GHz
Polarization RHCP IF = 720 MHz
G/T> 26 dB / K at 5 deg elevation auto-track and 6.1 m diameter
Receive satellite data SPOT-5/6/7, Landsat-7/8, Terra/Aqua

Figure 2.2. Parepare X-Band Viasat 5.4 m Antenna System

2.1.2. Zodiac X-Band Antenna 7.3 m

Lat: -3.978138 LS
Long: 119.649642 BT
Altitude: 72 m Antenna System
X Band 7.9 - 8.5 GHz
Polarization RHCP IF = 720 MHz
G / T> 32.7 dB / K at 5 deg elevation auto-track and 7.3 m diameter
Receive satellite data Peliades, Terasar-X, Tandem-X, SPOT -6/7, Landsat-7/8, Terra/Aqua

Figure 2.3. Parepare X-Band Zodiac 7.3 m Antenna System

2.1.3 Zodiac Antenna X Band and L Band 3.0 m

Lat: -3.977533 LS
Long: 119.650140 BT
Altitude: 72 m Antenna System
X Band 7.7 - 8.5 GHz
Polarization RHCP IF = 720 MHz
G / T> 24 dB / K at 5 deg elevation auto-track and 3 m diameter
Receive satellite data Terra, Aqua, NPP, METOP, NOAA Low-resolution satellite

Figure 2.3. Parepare L-Band Zodiac 3.0 m Antenna System

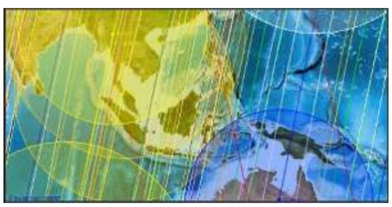
3. SIMULATION OF ANTENNA CAPABILITIES

In this paper, we will simulate the antenna's ability to record satellite data (Daim et al. 2015). We will simulate 3 antennas by entering the satellite path. By doing this simulation, it is hoped that the maximum ability of the satellite remote sensing ground station to receive satellites is expected.

The experiment carried out was to simulate 26 satellites that were acquired at the Parepare RSGS using 2 antennas, i.e. the Viasat and the Zodiac antenna. The simulation used in the JSatTrak software is by looking at the prediction pass of the satellite image data reception. The satellites used in the simulation are Aqua, Landsat-7, Landsat-8, Pleiades-1A, Pleiades-1B, SPOT-6, SPOT-7, Terra, TerraSAR-X, Skysat-1, Skysat-2, Skysat-C1, Skysat-C2, Skysat-C3, Skysat-C4, Skysat-C5, Skysat-C6, Skysat-C7, Skysat-C8, Skysat-C9, Skysat-C10, Skysat-C11, Worldview-1, Worldview-2, Worldview-3, Worldview-4.

3.1 Measured Parameters

The parameters that were observed when satellite passing using JSatTrak software, all the day of the month when all satellites pass on the track. At the same date, how many satellites passed the Parepare RSGS. The simulation is divided into 2 times, e.g. before 12 a.m. and after 12 p.m. as shown in Figure 2.5, the calculated parameters are the number of satellites that pass by, the time passes with a delay of 15 minutes. The time lag of 15 minutes between acquisition time to ensure the data has been acquired, recorded and the satellite acquisition process has completed.



(a). Skysat C8, Skysat C9, Worldview 3, Skysat C1, Pleiades 1B

(b). Terra, Skysat C7, Skysat C2, Worldview 2, SPOT 6

Figure 2.5. JSatTrak simulation in the morning before 12 a.m. and in the afternoon after 12 p.m

From the simulation results, it can be seen the number of satellites that were successfully recorded, the number of failed passes, and the percentage of success.

3.2 Simulation Results

These morning results of the simulation can be seen in the Table 3.1. below. For the Morning Track Acquisition Schedule starting from 06 to 12 a.m. From this simulation, 19 satellites passed each day.

Table 3.1. List of Morning Satellite Trails

No	Satellite	Viasat Pass	Percentage Of Success Viasat	Zodiac Pass	Percentage Of Success Zodiac	Total Presentation Success Rate
1	Skysat-C6	11	84.61538	2	15.38462	100
2	Skysat-C7	7	43.75	7	43.75	87.5
3	Skysat-C8	7	46.66667	4	26.66667	73.33333
4	Aqua	2	18.18182	8	72.72727	90.90909
5	Worldview-2	19	41.30435	17	36.95652	78.26087
6	Pleiades-1A	18	41.86047	11	25.5814	67.44186

7	Skysat-C1	17	48.57143	10	28.57143	77.14286
8	Skysat-C3	8	23.52941	12	35.29412	58.82353
9	SPOT-6	20	46.51163	14	32.55814	79.06977
10	Terra	14	32.55814	15	34.88372	67.44186
11	Skysat-C4	12	34.28571	11	31.42857	65.71429
12	Worldview-3	12	31.57895	12	31.57895	63.15789
13	Pleiades-1A	15	35.71429	13	30.95238	66.66667
14	Landsat-8	21	47.72727	9	20.45455	68.18182
15	SPOT-7	23	53.48837	12	27.90698	81.39535
16	Skysat-C5	12	34.28571	9	25.71429	60
17	Landsat-7	25	58.13953	9	20.93023	79.06977
18	Skysat-C2	10	28.57143	8	22.85714	51.42857
19	Skysat-C9	9	60	5	33.33333	93.33333

These afternoon results of the simulation can be seen in the Table 3.2. below. For the Afternoon Track Acquisition Schedule starting from 00 to 06 p.m. in the morning. From this simulation, 11 satellites passed each day.

Table 3.2. List of Afternoon Satellite Trails

No	Satellite	Viasat Pass	Percentage of Success Viasat	Zodiac Pass	Percentage of Success Zodiac	Total Presetation Success Rate
1	Skysat-C9	4	21.0526	8	42.1053	63.1579
2	Skysat-C10	17	89.4737	2	10.5263	100
3	Worldview-4	7	38.8889	6	33.3333	72.2222
4	Skysat-C11	17	89.4737	2	10.5263	100
5	Skysat-C6	19	86.3636	3	13.6364	100
6	Skysat-C7	13	72.2222	3	16.6667	88.8889
7	Skysat-C8	14	77.7778	2	11.1111	88.8889
8	Aqua	15	46.875	15	46.875	93.75
9	Worldview-1	11	37.931	14	48.2759	86.2069
10	Skysat-2	36	87.8049	5	12.1951	100
11	TerraSAR-X	30	85.7143	5	14.2857	100

Based on the simulation results as shown in Table 3.1 dan 3.2 where carried out on the prediction pass of 26 satellites using 2 antennas, it can be concluded that the majority of satellites will have a potential conflict on the reception of the satellite image data. The satellites that do not experience a potential conflict are the Skysat-C11, Skysat-C6, TerraSAR-X, and Skysat-2 satellites. For potential conflicts that occur on two satellites such as the Worldview-4 vs Skysat-C10, Skysat-C10 vs Aqua, Aqua vs Skysat-C11, Skysat-C7 vs Worldview-1, Worldview-1 vs Skysat-C8, Worldview-4 vs Skysat-C10, SPOT-6 vs Terra can be solved by using both Viasat and Zodiac antennas simultaneously. However, for satellites that experience potential conflicts based on their prediction pass, prioritization scale analysis or additional antennas are required to receive the satellite image data.

All the simulation result analysis are shown below. Total number of morning runs for Viasat and Zodiac are 290 and 201, respectively. It will get conflict passed around 179 times, and it seems 26.72% antenna conflict as shown in Table 3.3. and 3.4 below.

Tabel 3.3. Total Number of Morning Runs

No	Antenna	Track
1	Number of Viasat Pass	290
2	Number of Zodiac Pass	201
3	Total Track Schedule Conflicts	179
	Total Satellite Trajectory Data	670

Tabel 3.4. Number of Morning Track Percentages

No	Antenna	Percentage of Success and Conflict
1	Viasat	43.284 %
2	Zodiac	30 %
3	Antenna Conflict	26.716 %

And total number of afternoon runs for Viasat and Zodiac are 183 and 65, respectively. It will get conflict passed around 22 times, and it seems 8.15% antenna conflict as shown in Table 3.5. and 3.6 below.

Table 3.5. Total Number of of Afternoon Runs

No	Antenna	Track
1	Number of Viasat Pass	183
2	Number of Zodiac Pass	65
3	Total Track Schedule Conflicts	22
	Total Satellite Trajectory Data	270

Table 3.6. Number of Afternoon Track Percentages

No	Antenna	Total Day Track Percentage
1	Viasat	67.7778 %
2	Zodiac	24.0741 %
3	Antenna Conflict	8.14815 %

Jika kita melakukan filter satelit yang berhasil di tracking di atas 80 persen makan jumlah satelit yang dapat di tracking berkurang menjadi 15. Apabila kita melakukan filter menjadi 90 persen maka satelit yang mampu direkam adalah 12.

4. CONCLUSION

In our calculations and simulations, the maximum value of the satellite that can be recorded is 12. Based on the simulation results as shown in Table 3.1 dan 3.2 where carried out on the prediction pass of 26 satellites using 2 antennas, it can be concluded that the majority of satellites will have a potential conflict on the reception of the satellite image data. The satellites that do not experience a potential conflict are the Skysat-C11, Skysat-C6, TerraSAR-X, and Skysat-2 satellites. For potential conflicts that occur on two satellites such as the Worldview-4 vs Skysat-C10, Skysat-C10 vs Aqua, Aqua vs Skysat-C11, Skysat-C7 vs Worldview-1, Worldview-1 vs Skysat-C8, Worldview-4 vs Skysat-C10, SPOT-6 vs Terra can be solved by using both Viasat and Zodiac antennas simultaneously. However, for satellites that experience potential conflicts based on their prediction pass, prioritization scale analysis or additional antennas are required to receive the satellite image data.

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