Design and Implementation of SatGate / iGate YF1ZQA for APRS on the LAPAN-A2 Satellite

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***Abstract*—LAPAN-A2 Satellite, also known as LAPAN-ORARI, is the second satellite developed by the Indonesian National Institute of Aeronautics and Space (LAPAN), especially by Satellite Technology Center. This satellite was launched in 2015, where one of the missions is to support disaster mitigation through the Automatic Packet Reporting System (APRS). The APRS is a method of transmitting messages, status, and positions – using specially formatted AX.25 packets messages. The critical part of the APRS infrastructure is Digital Repeater (*digipeater*) and Internet Gateways (*iGates*). The digipeater is usually used to retransmit data packets for extending coverage. The APRS digipeater of LAPAN-A2 is on 145.825 MHz. The iGate is a type of gateway APRS station that functions to collect packages from the radio and feeds them into a worldwide data streams on the internet. This paper describes the design and implementation of SatGate /iGate YF1ZQA for APRS on the LAPAN-A2 Satellite.**

Keywords—satellite, LAPAN-A2, APRS, iGate

I. INTRODUCTION

Fundamentally, APRS is a communication system for disseminating data such as messages, status, and position to everyone on a network in real-time [1]. Bob Bruninga, WB4APR, designed it and introduced by him at the 1992 TAPR/ARRL Digital Communications Conference [1] [2]. The communication protocol used by the APRS is AX.25 packets messages [1] [3]. The AX.25 protocol is a part of the High-level Data Link Control (HDLC) [4]. This protocol is often used by the amateur radio community, especially the form of APRS. It operates on a single VHF channel and 1200 baud Audio Frequency Shift Keying (AFSK) modulation [5].

The missions of LAPAN-A2 Satellite are earth observation, ship monitoring by using Automatic Identification System (AIS), and amateur radio communication [8][15]. For amateur radio communication missions, LAPAN-A2 is equipped with voice repeater (VR) and APRS. Establish connection among the Indonesian amateur radio communities (ORARI) using amateur radio frequency for position monitoring, communication from distress area, and disaster mitigation [7] through APRS. Furthermore, APRS is also widely used for monitoring sensors [6], sending telemetry data and transmitter.

Fig. 1 describes the APRS infrastructure and how data flows from the tracker to the application, which can visualize information. The tracker or mobile tracker broadcast data packets and maybe re-transmitting through on-air by digipeaters to extend the range of other stations. The Internet gateway for APRS is known as an iGates. And then an iGates collect packets from the radio and feeds them into a worldwide data streams on the internet [5].

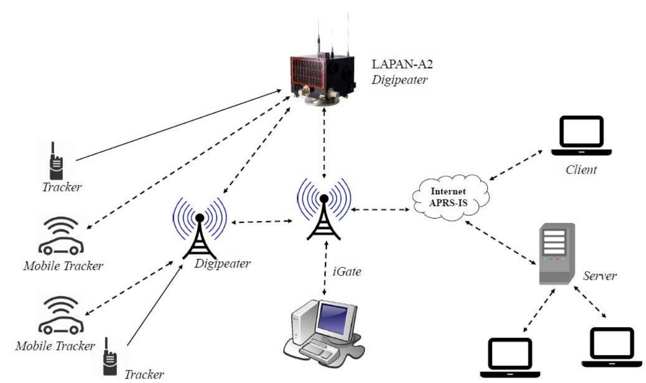

Fig. 1. APRS Infrastructure

An iGate is an essential component of the APRS infrastructure in sending data packets. The iGates stations allow communication between disjoint radio networks by enabling some content to flow between them over the Internet [9]. Therefore, the APRS payload on the LAPAN-A2 satellite needs to be equipped with SatGate /iGate station. The main application of APRS on the LAPAN-A2 satellite is for disaster mitigation. Satellite Technology Center (Pusteksat) APRS station has a callsign YF1ZQA and LAPAN-A2 satellite, which has an APRS mission using callsign YBSAT [10]. We have designed and implemented SatGate/iGate YF1ZQA for APRS on the LAPAN-A2 satellite.

II. METHODOLOGY

There are two system design options for iGate implementation, and the one is by using the terminal node controller (TNC) and the second without using TNC. The TNC is a device commonly used by amateur radio users using the AX.25 protocol [11]. This device functions as a modem and formats radio data according to the protocol requirements used [13]. More clearly, we can see Fig. *2*, the radio signal is demodulated by TNC so that radio audio can be passed straight to a computer and then interpreted by special software. The advantage of demodulation through software is that it eliminates the need for specialized hardware, like TNC. We can reduce the cost of purchasing equipment, so we choose the second option, without using TNC.

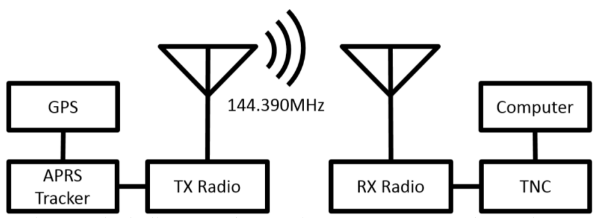

Fig. 2. Block diagram of example APRS System end to end [12]

A. *System design*

By using a computer's sound card, audio from the radio can be processed using the software, which will decode received packets, or audio can be played from the sound card to the radio to be transmitted. With the abundance of computers, this can provide a much cheaper solution for implemented SatGate /iGate station [12]. Fig. 3 show system design of SatGate /iGate station in Pusteksat, Bogor. The radio receives signals from satellites according to a predetermined frequency. Through an additional 'sound card,' the computer processes the radio signals received with special software for demodulation.

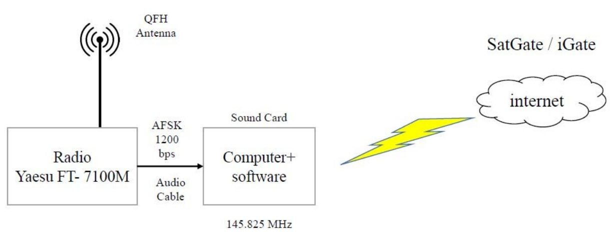

Fig. 3. System design of SatGate/iGate station.

B. *Supporting device*

The primary devices of this system are the radio and computer. The radio used is Yaesu FT-7100M, which works in the frequency range 108.00 – 180.00 MHz for the receiver and 144.00 – 146.00 MHz or 144.00 – 148.00 MHz for the transceiver [14]. The computer must be equipped with a 'sound card,' which is an additional facility on a computer that used to provide audio signals.

- Radio

Fig. 4 show an image of the Yaesu FT-7100M Radio. The radio works on the frequency of 145825 MHz and has a data rate of 1200 bps.


Fig. 4. Picture of the Yaesu FT-7100M Radio

- Computer

Fig. 5 shows the computer for iGate station. After the sound card is installed on the computer, we can determine which software you want to use. The software used for demodulation is UZ7HO SoundModem, and besides that, we can also use UISS.

Fig. 5. A Computer for iGate station

C. *Configuration*

There are two configurations we can use, one is based on hardware decoder, and the other is by using the software program to decode a code of APRS. For reducing a cost, we choose to the used option by using a software method because we can save a price of around $150, to compare this both can be seen in TABLE I. below.

TABLE I. DEVICE REQUIREMENTS

Decode based on :	**Devices**			
	PC	***Antenna***	***Radio***	***TNC***
Software	√	√	√	-
Hardware	√	√	√	√

Back then, we need TNC hardware to decode the known APRS data, which can cost around $150 extra for the system. Nowadays, the software can act as a TNC modem to replace it. Because the software program itself is free, so there are no costs.
By using an antenna to receive frequency for APRS with AFSK 1200 bps, a radio will pass the audio signal to input the sound

card, and here the Soundmodem software will work as done by the TNC APRS modem.

III. RESULT AND DISCUSSION

In this chapter, we discuss the results of the implementation of SatGate /iGate station.

A. Result of software modem

In Fig. 6 below show the main screen of SoundModem. Here we can configure the device and modem used. The raw packet can be seen on the monitor, and there are packets sent and packets received have been decoded.

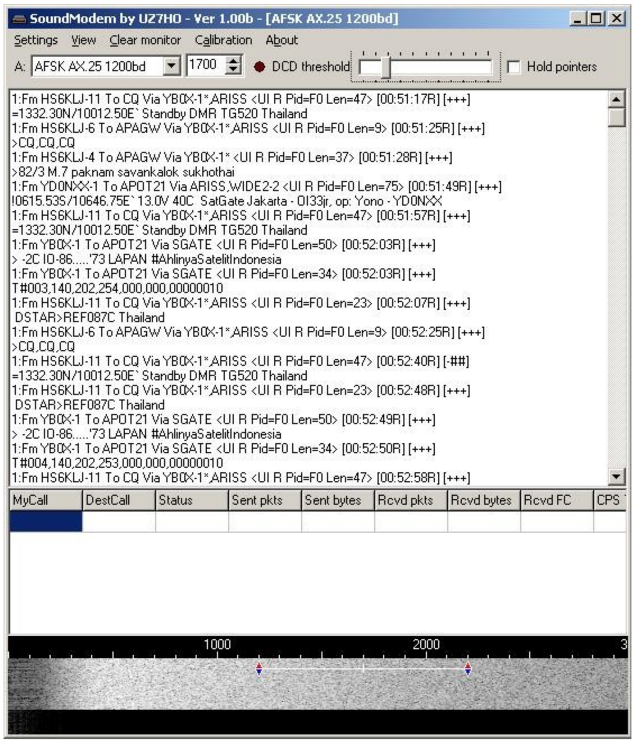

Fig. 6. The Main Screen of SoundModem

The sound modem will act as TNC did, he will decode a signal that came from the radio (AX.25) to be an ASCII text that we can understand, the sound modem can be linked with UISS software like in Fig. 8, and we can see the data that came from any callsign. And for the gateway, it's self we were using APRSIS32 in Fig. 7 below.

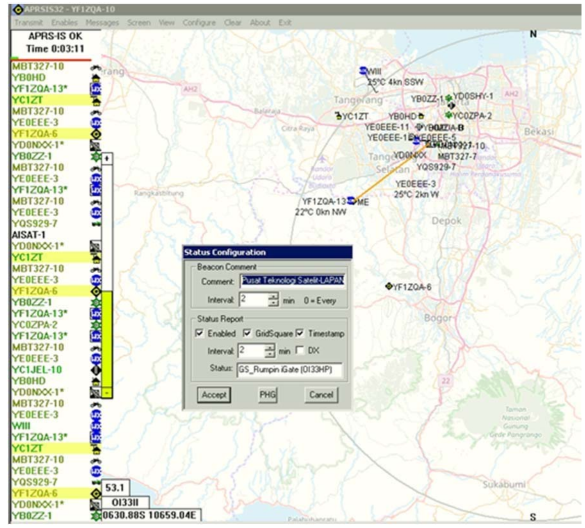

Fig. 7. APRSIS32 to feed information to the internet.

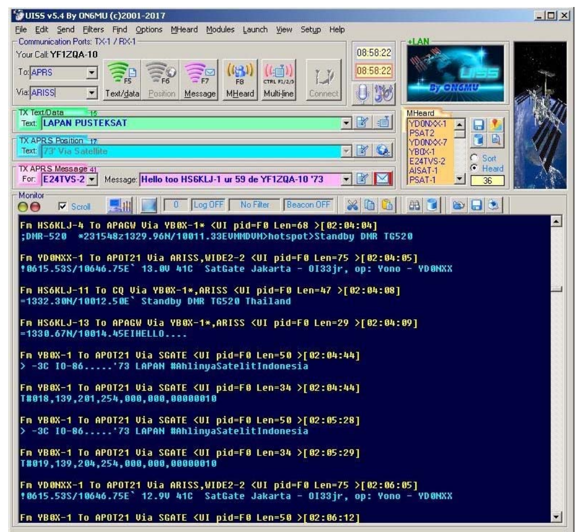

Fig. 8. The data raw from UISS

With UISS, we can make a log for how many callsigns are heard/coming to our gateway. This is very useful for further searches, like in Fig. 9.

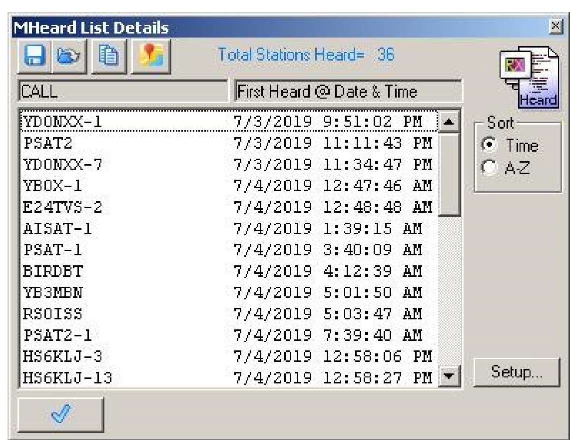

Fig. 9. MHeard List Details.

B. Result of Data Center

Fig. 10 show view map from www.aprs.fi. The data packet from APRS LAPAN-A2 can be viewed in one of the data centers on the internet, like aprs.fi.

This aprs.fi database can save raw data that came from Satellite like LAPAN-A2 / LAPAN-ORARI with his callsign YB0X-1 that received by YF1ZQA iGate and linked information to this aprs.fi server and can be accessed from anywhere around a globe just by using an internet browser to see the data.

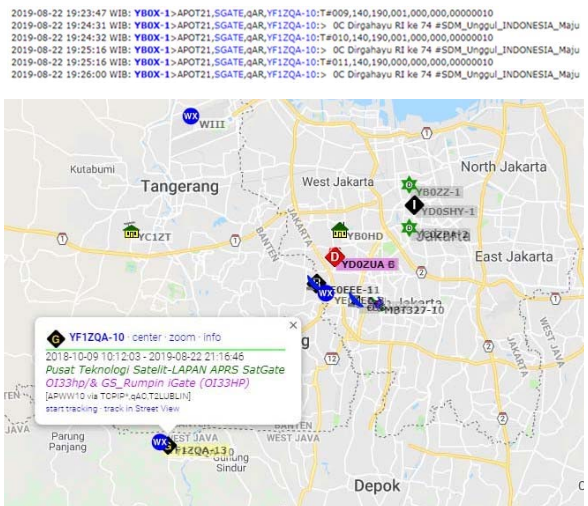

Fig. 10. View Map from aprs.fi.

IV. Conclusion

The SatGate/iGate YF1ZQA has been implemented for APRS on the LAPAN-A2 satellite. The simulation results show that the packet data was successfully viewed on the internet so that iGate can run well. This implementation is also without using TNC, which can reduce installation costs. Hardware commonly used for demodulation processes such as TNC can be removed and replaced with existing software on a computer with an added 'soundcard.' In the future, there will be another APRS payload that put in the next satellite for digital communication, and a presentation of APRS iGate will very useful for cover that area especially in Indonesia.

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REFERENCES

[1] APRS Working Group, *APRS Protocol Reference: Protocol Version 1.0,* Arizona: TAPR Corporation, 2000.

[2] B. Bruninga, APRS: Automatic Packet Reporting Systems, 2014

[3] W. A. Beech, D. E. Nielsen, and J. Taylor, AX.25 Link Access Protocol for Amateur Packet Radio, Tucson: Tucson Amateur Packet Radio Corporation, 1997.

[4] ___ISO/IEC 13239, Information technology – Telecommunications and Information Exchange Between Systems – High-level Data Link Control (HDLC) Procedures, Third Edition, Geneva: ISO, 2002.

[5] O. Hanssen "Position Tracking in Voluntary Search and Rescue Operations," Proceedings of the ISCRAM 2015 Conferences, 2015.

[6] A. Goeritno, R. Yatim, and D.J. Nugroho, "Implementasi Automatic Packet Reporting System (APRS) untuk Paket Data dan Pengukuran," The 3rd National Conference on Industrial Electrical and Electronics, 2013.

[7] S. Y. Prahyang et al., "Development of nanosatellite Technology with APRS Module for Disaster Mitigation," IOP Conf. Ser.: Earth Environ. Sci. **149** 012072, 2018.

[8] R. H. Triharjanto R. H "The Comparison of LAPAN-A1 and LAPAN-A2 System Design: Weight Ratios and Moment Inertias Analysis", International Seminar of Aerospace and Technology II, 2015

[9] _, Dire Wolf User Guide, 2018.

[10] R. Hartono, I. Choiriyah, W Hasbi, and R. Yatim "Design of APRS Modem Using IC TCM3105 and ATMEGA2560 Microcontroller" International Journal of Advanced Studies in Computer Science and Engineering, 2018, volume 7 issue 12.

[11] R. D. Straw, N6BV, "The ARRL Handbook for Radio Communication 2006", American Radio Relay Leage.

[12] R. F. Campbell, Thesis: Analysis of Various Algorithmic approaches to Software-Based 1200 Baud Audio Frequency Shift Keying Demodulation for APRS, 2016

[13] Y. A. Ahmad, N. J Nazim, and S. S. Yuhaniz "Design of a terminal node controller hardware for CubeSat tracking applications" IOP Conf. Series: Materials Science and Engineering, 2016.

[14] Yaesu, VHF/UHF Dual-band FM Transceiver FT-7100M Operating Manual, Hampshire: Yaesu UK Ltd.

[15] W. Hasbi & A. Karim, "Lapan-A2 System Design for Equatorial Surveillance Missions." The 9th International Academy of Astronautics (IAA) Symposium on Small Satellite for Earth Observation: Mission & Technologies, Operational Responsive Space, Commercial Constellations, 2014, Berlin: International Academy of Astronautics, vol. 1, pp. 8-12.