REMOTE SENSING AND TELEMETRY
GROUP 1

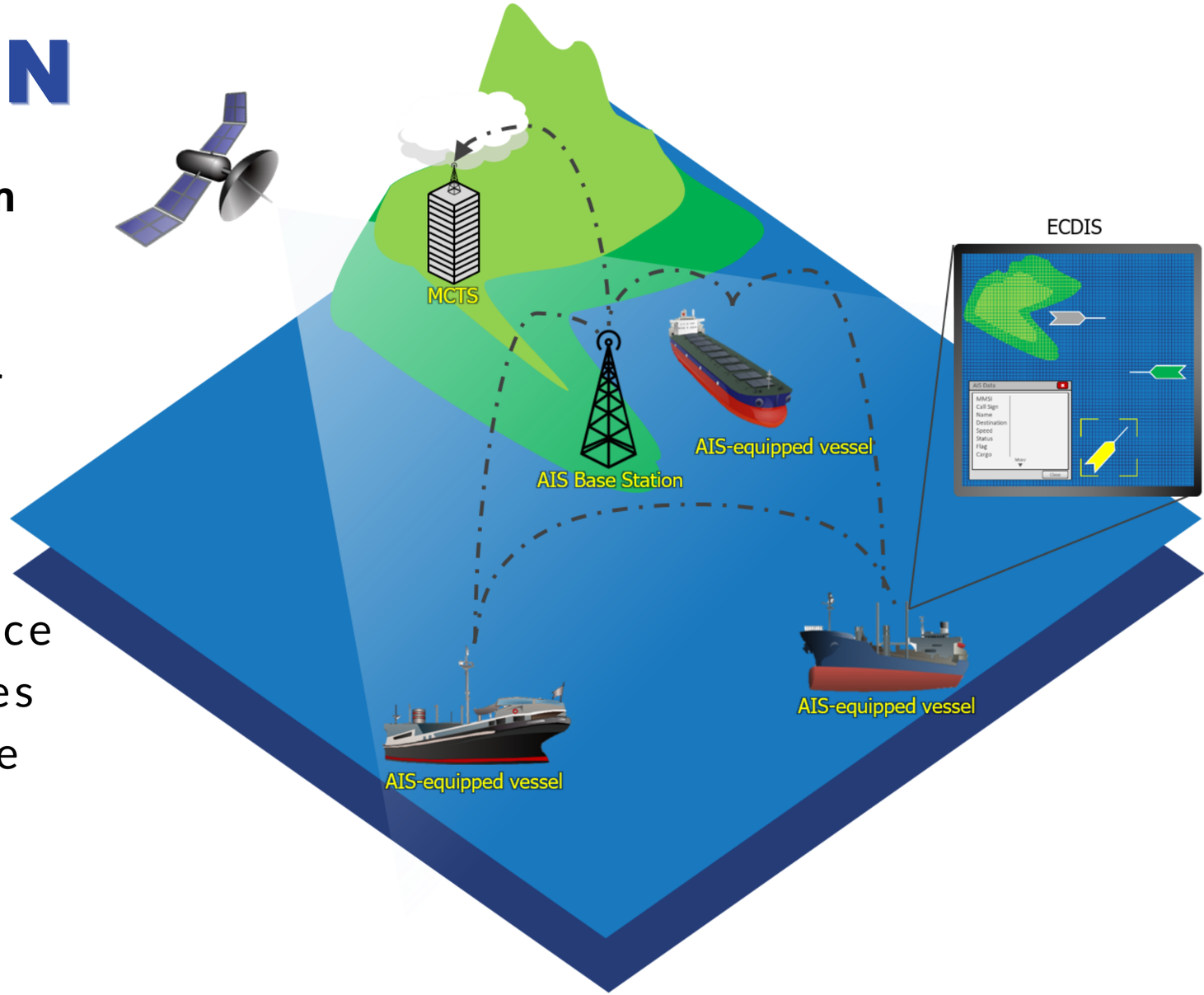
TELEMETRY FOR AIS USING

SV651 (433MHZ) + ROCKBLOCK MK2 (IRIDIUM)

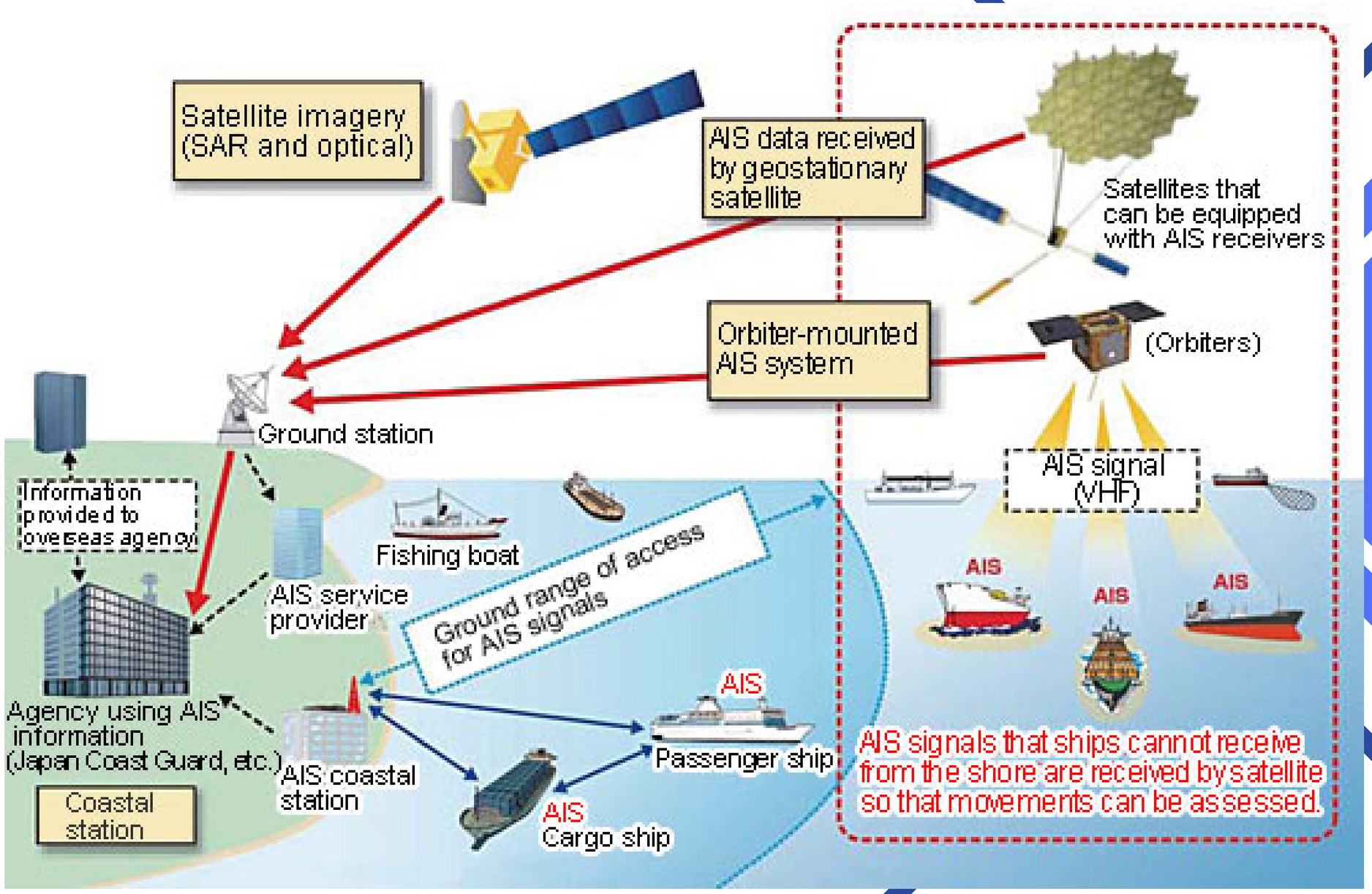
INTRODUCTION

Automatic Identification System (AIS)?

- Maritime transponder/receiver system to improve maritime safety and maritime environment.
- Assists ship's collision avoidance
- Enables ports and coastal states to identify ships and to manage supervise the traffic in their waters.



PROJECT CONCEPT



OBJECTIVES

- TO TRANSMIT THE POSITION OF A SHIP USING GPS TO BASE AT REGULAR INTERVALS VIA ROCKBLOCK IRIDIUM & SV651 FOR A DISTANCE BELOW 3KM AND ROCKBLOCK IRIDIUM FOR A DISTANCE ABOVE 3KM.
- TO RECEIVE THE TRANSMITTED GPS DATA BY USING IRIDIUM CLOUD MONITORING AND LOCAL GROUND CONTROL STATION (GC).

GARMIN GPS 19X HVS

- Consist of an antenna and an integrated receiver.
- Tracks many satellites simultaneously.
- Built to survive harsh operating circumstances.
- Waterproof to IEC 60529 IPX7.
- GLONASS based tracking

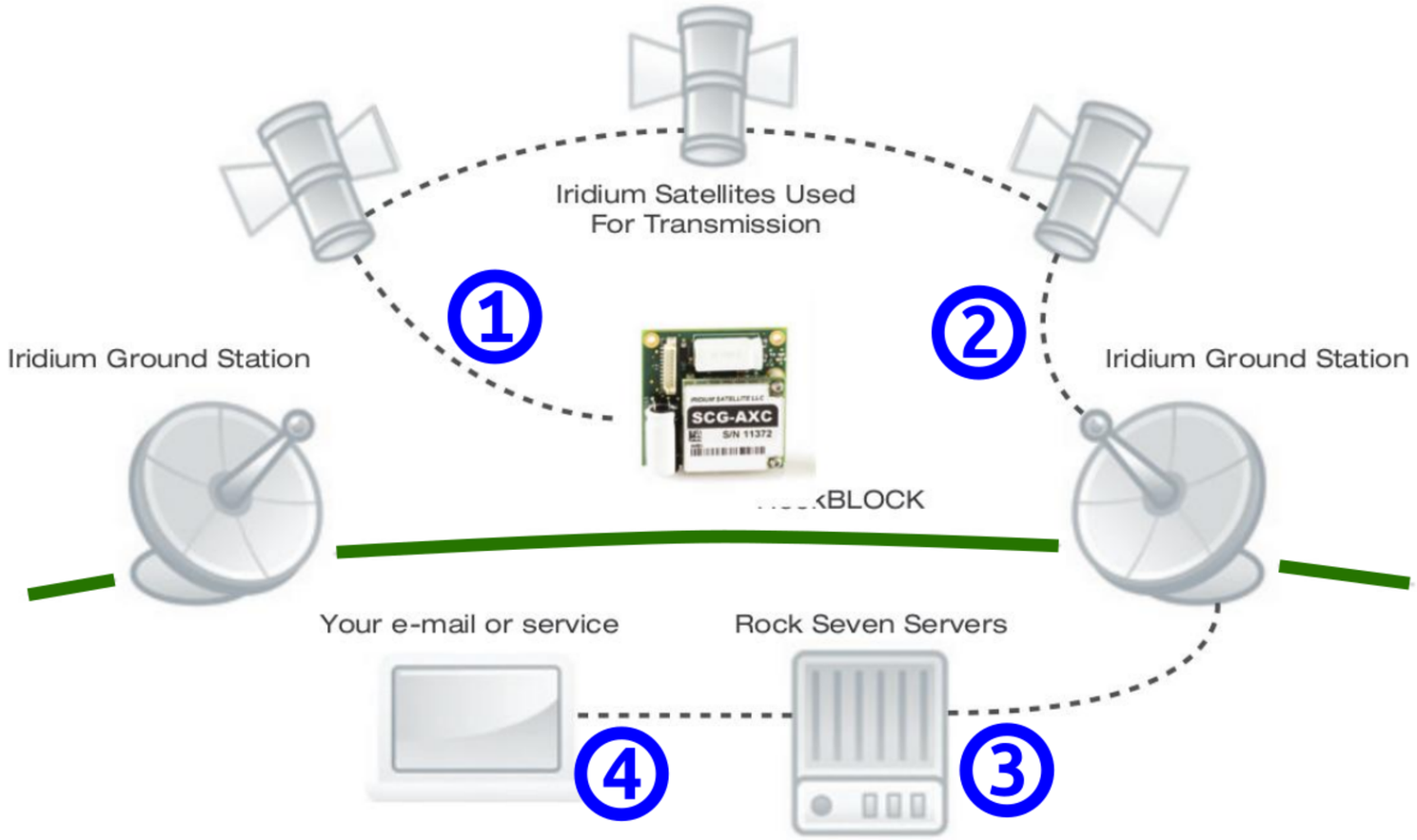
ROCKBLOCK MK2 IRIDIUM

- Send and receive brief messages from anywhere on the planet.
- Iridium 9602 satellite modem is the heart of RockBLOCK.
- The only satellite network that permits data to be transmitted from any location on Earth.
- Messages transmitted by Iridium arrive either via email or directly to the user's web service.

SV651 (433MHZ)

- Industrial grade and highly integrated RF transceiver module.
- High sensitivity and output power of 500mW.
- Allow for a long RF range and dependable RF transmission.
- Has 40 frequency channels and customizable Net ID to prevent interference.

PROJECT OVERVIEW



1. The RockBLOCK 9602 communicates with the Iridium satellites to send/receive data.
2. The Iridium satellites communicate with ground based stations to send/receive data between space and Earth.
3. Data is sent between the Iridium ground stations and the Rock Seven Servers. The server can be accessed via a web interface.
4. The specific applications talks to the Rock Seven servers.

DESIGN PROBLEM

1

RECEIVING SERIAL DATA FROM GPS

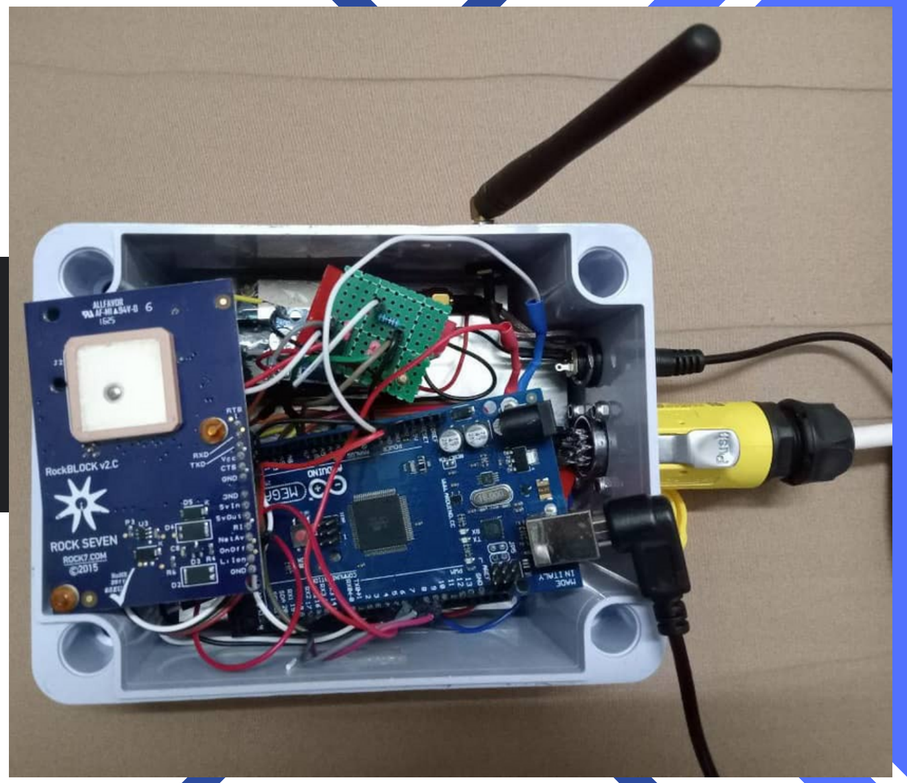
Difficulty to solve problems of different logic levels Arduino TTL to RS232 to read the GPS data.(GPS output a 0-3.3 CMOS logic level)

2

Valid RS-232 signals are either in the range of +3 V to +15 V or the range −3 V to −15 V with respect to the common ground (Figure 1-1). To be more specific, the driver output is **Logic 0 when the voltage is between +5 V and +15 V and is Logic 1 when the voltage is between -5 V to -15 V**.

ROCKBLOCK INTEGRATED ANTENNA NEEDS A CLEAR VIEW OF THE SKY

It is very possible that a satellite may have had an unobstructed view of the RockBLOCK, returned a 5 bar signal and then disappeared behind an obstruction or even the horizon itself.



CLIENT

HIDROKINETIK TECHNOLOGIES


Project
Demo

DATA COLLECTION

LOCATION

- *Collecting the raw GPS data*

DATA COLLECTION

LOCATION

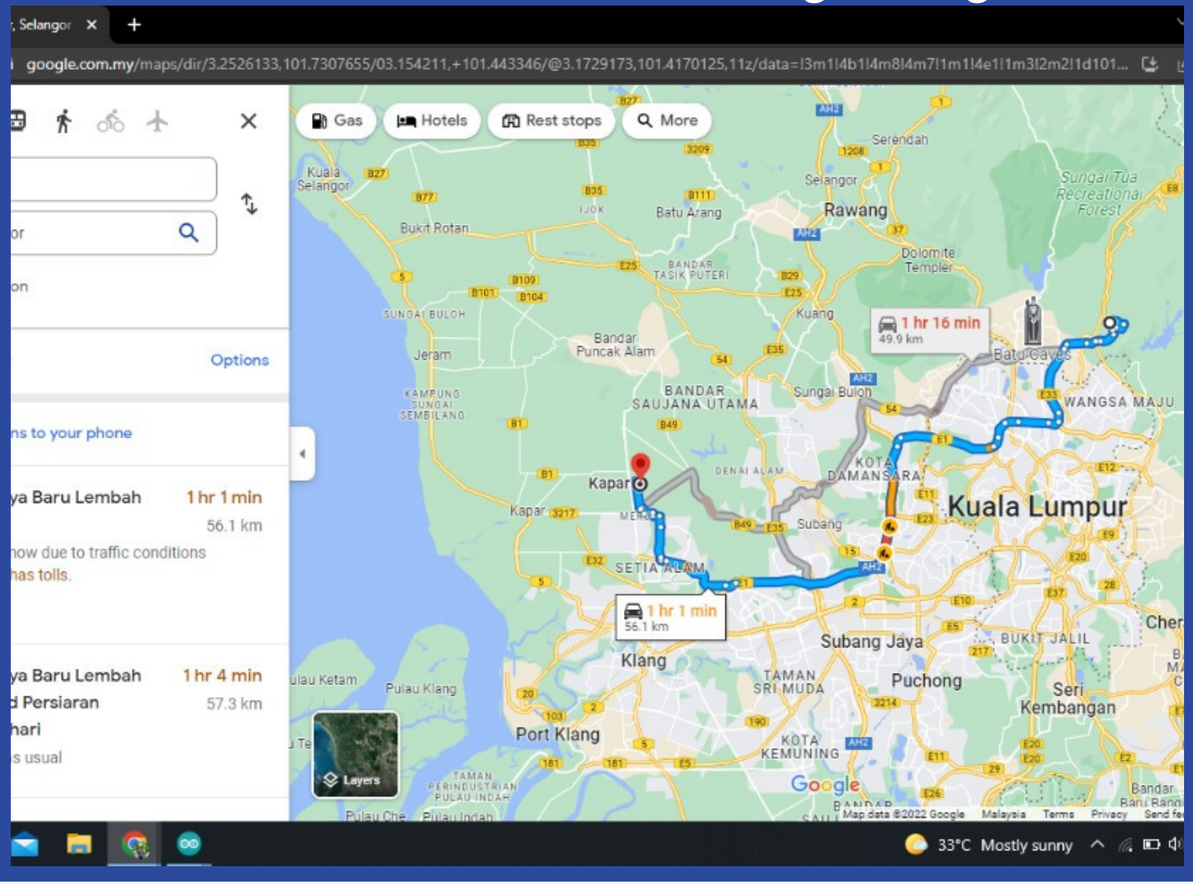
- *Collecting raw GPS data*

```
}

void loop() {
  // put your main code here, to run repeatedly:

}
```

DATA COLLECTION

LOCATION DATA

- *Callibrating the GPS input (manually callibrating using Local GPS data in the program)*
- *Normal GPS is callibrated using triangulation of cell towers and local atomic clock time.*



Calibrating the High Performance Marine Heading Sensor

Warning: The internal compass must be calibrated on the water after the sensor is installed. Failure to do so may result in inaccurate compass readings, possibly contributing to damage to the boat and/or personal injury.

Caution: Compass calibration needs to be done in calm seas in a 0.8 km (0.5 mile) open area away from other boats or ferrous objects (structures or aids to navigation). Avoid congested areas and waters with strong currents as calibration will be difficult and possibly hazardous.

Important: Calibration requires the vessel to complete 2 to 3 circles

AutoCalibration Procedure:

1. Navigate the vessel to an open area of water, 0.8 km (0.5 mile) of open space away from other boats or ferrous objects (structures or aids to navigation). Choose calm seas.
2. Select the display page on the vessel's NMEA instrument that shows Heading.
3. Shut OFF and then turn ON the DC power that is connected to the sensor.
4. Within 2 minutes of recycling power to the sensor, start the vessel in a slow [4 to 6 knots (4.5 to 7 MPH)] circular turn that takes about 2 to 3 minutes to complete. *
    1. If the vessel completes 1.5 circles within 3 to 4.5 minutes, AutoCalibration will begin. Heading will stop being reported on any NMEA 0183 or NMEA 2000 display until the calibration is finished.
5. Keep turning the vessel in the same circle for 1 to 2 more complete circles. Do not change the vessel speed or rate of turn through the circle.
6. When calibration is completed successfully, Heading will return to the display. If calibration fails, the display will flash Heading ON and OFF in 10 second intervals for 60 seconds. (Display times may vary by manufacture.)

Important: In the event of a calibration failure, repeat the procedure.

* The optimum rate of turn is 180 degrees/ minutes: 3 degrees/second, 30 degrees/10 seconds, 45 degrees/15 seconds, and 90 degrees/30 seconds.

DATA PROCESSING

FORMATTING DATA

- *Turning the GPS data to AIS data after callibration*
- *List of data from GPS:*
  - *Latitude*
  - *Longitude*
  - *GPS quality*
  - *Direction*
  - *Number of Satellite*
  - *Accuracy*
  - *Altitude from sea level*
  - *Height of antenna(set by user)*
  - *Geoidal saperation (Real altitude difference)*

- *List of data required for AIS:*
  - *Latitude → From GPS*
  - *Longitude →From GPS*
  - *Speed → From GPS*
  - *Accuracy → From GPS*
  - *Heading → From GPS*
  - *------user defined data-------*
  - *Date(ISO 8601)*
  - *Time(ISO 8601)*
  - *Msg Type(AIS data type 1 - 27)*
    - *Type 1 - position message*
    - *Type 2 - Static message*
  - *Country of Origin*
  - *Data Collection (terres or sattellite)*
  - *MMSI(identification number)*
  - *Length & Width of vessel*

DATA PROCESSING

AIS DATA ENCODING AND DECODING

- *AIS data uses 2 layer-encoding (string to binary to hexa)*
- The ASCII format has been defined in IECPAS 61162-100 standard, "Maritime navigation and radio communication equipment and systems"
- *Require special software or library to encode and decode.*
- *Vessel carrying high-value items will implement further key encryption of AIS data and impossible to be cracked by unauthorized party.*

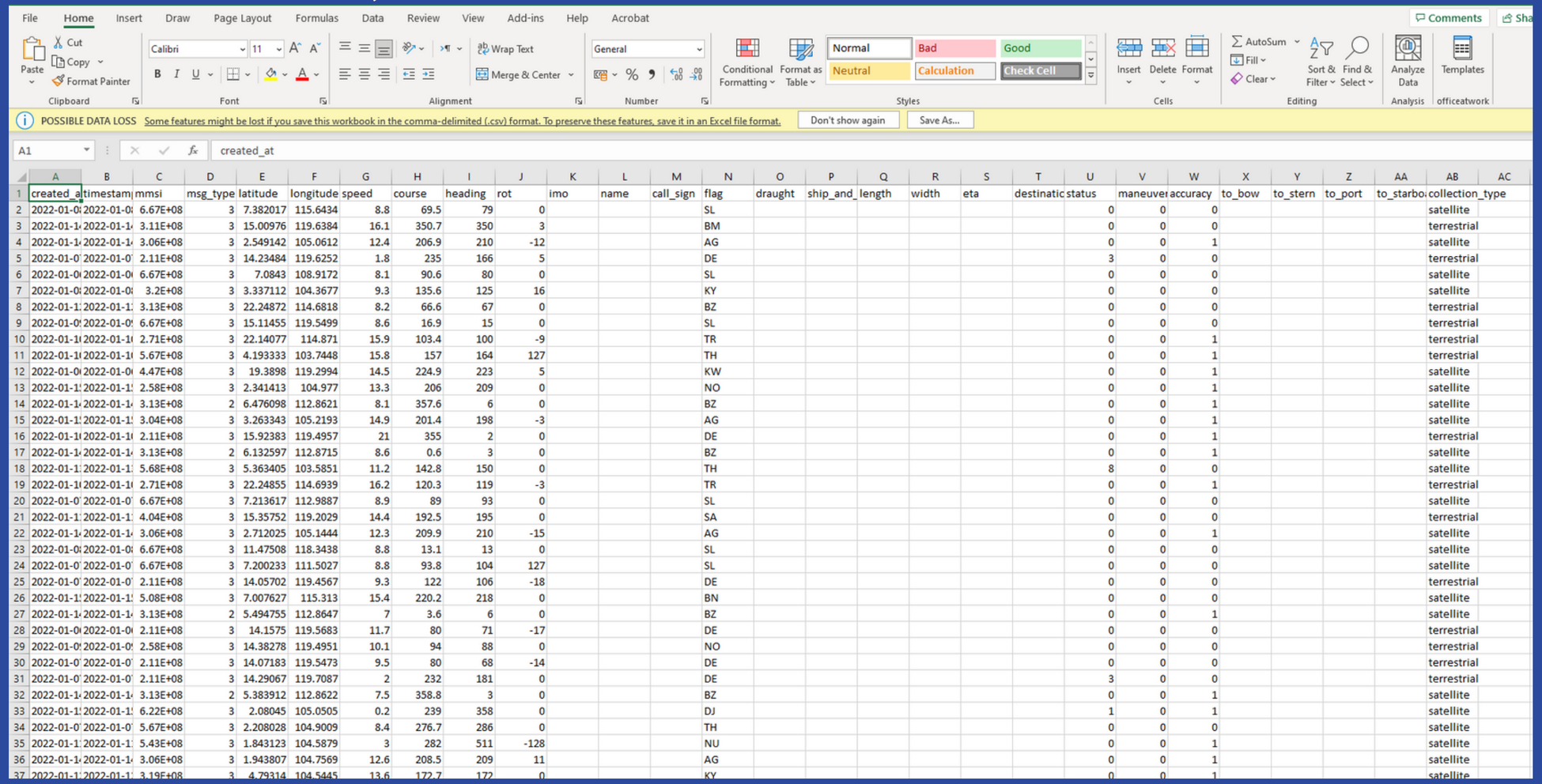
```
21/04/2016 15:00:00    !AIVDM,1,1,,A,376ru=0PAFwL8Qp0ejKTkSCL0120,0*7F
21/04/2016 15:00:02    !AIVDM,1,1,,B,16U?FL0u1uwL8>T0f4waoGoL08Jo,0*00
21/04/2016 15:00:02    !AIVDM,1,1,,A,18KGqL0P007Kqs`0gJPmc?wF08Jq,0*1E
21/04/2016 15:00:02    !AIVDM,1,1,,B,13f=?D000f7JjjJ0ehNq8GSL0684,0*0E
21/04/2016 15:00:02    !AIVDM,1,1,,B,18JwK20P007KFJp0f36JL?wL08Jl,0*77
21/04/2016 15:00:02    !AIVDM,1,1,,B,18JwK20P007KFJp0f36JL?wL08Jl,0*77
21/04/2016 15:00:02    !AIVDM,1,1,,B,18JwK20P007KFJp0f36JL?wL08Jl,0*77
21/04/2016 15:00:02    !AIVDM,1,1,,B,18JwK20P007KFJp0f36JL?wL08Jl,0*77
21/04/2016 15:00:02    !AIVDM,1,1,,B,18JwK20P007KFJp0f36JL?wL08Jl,0*77
21/04/2016 15:00:02    !AIVDM,1,1,,B,18JWOj0P0Q7KV;D0fHe`H?wHO@Jt,0*5D
21/04/2016 15:00:02    !AIVDM,1,1,,B,18L0nr00007Jq>N0gEvja3UL0<<=,0*07
21/04/2016 15:00:02    !AIVDM,1,1,,B,18HsJG8P007K1JJO`mI<1wwMp8Jv,0*27
21/04/2016 15:00:02    !AIVDM,1,1,,A,17lcic@0017L1mb0bt07oT7L00RL,0*4E
21/04/2016 15:00:02    !AIVDM,1,1,,B,18IgmB8P007K@260f?i:WgwN0PRw,0*0B
21/04/2016 15:00:02    !AIVDM,1,1,,A,15?:4d001D7LE:R0fF8::89L00S;,0*59
21/04/2016 15:00:02    !AIVDM,1,1,,B,18Hsa5P02T7KUJv0eR2joBAL28K2,0*5C
21/04/2016 15:00:02    !AIVDM,1,1,,B,15Q4cP00007KQ4h0fPo4PaEL0D>D,0*6D
21/04/2016 15:00:02    !AIVDM,1,1,,A,13clS300007JMdd0dnvafs3L08K6,0*69
21/04/2016 15:00:02    !AIVDM,1,1,,A,18J8w>80017K2l<0fcMqJ0uN08K7,0*1F
21/04/2016 15:00:02    !AIVDM,1,1,,B,18KeP@00017Ku0b0gq;aoqqNO<;`,0*42
21/04/2016 15:00:03    !AIVDM,1,1,,A,18Hs290P007KIHT0fQ8VU?wN08K9,0*16
```

Table 1: *AIS Decode Message*

Bit	Length	Comments
0-5	6	Message Type
6-7	2	*Repeat Indicator*
8-37	30	MMSI
38-41	4	Status Kapal
42-49	8	*Rate of Turn (ROT)*
50-59	10	*Speed Over Ground (SOG)*
60-60	1	*Position Accuracy*
61-88	28	*Longitude*

DATA PROCESSING

FORMATTING DATA (AIS DATA IN SOUTH CHINA SEA 2020 - JUNE 2022)



File Home Insert Draw Page Layout Formulas Data Review View Add-ins Help Acrobat

POSSIBLE DATA LOSS Some features might be lost if you save this workbook in the comma-delimited (.csv) format. To preserve these features, save it in an Excel file format. Don't show again Save As...

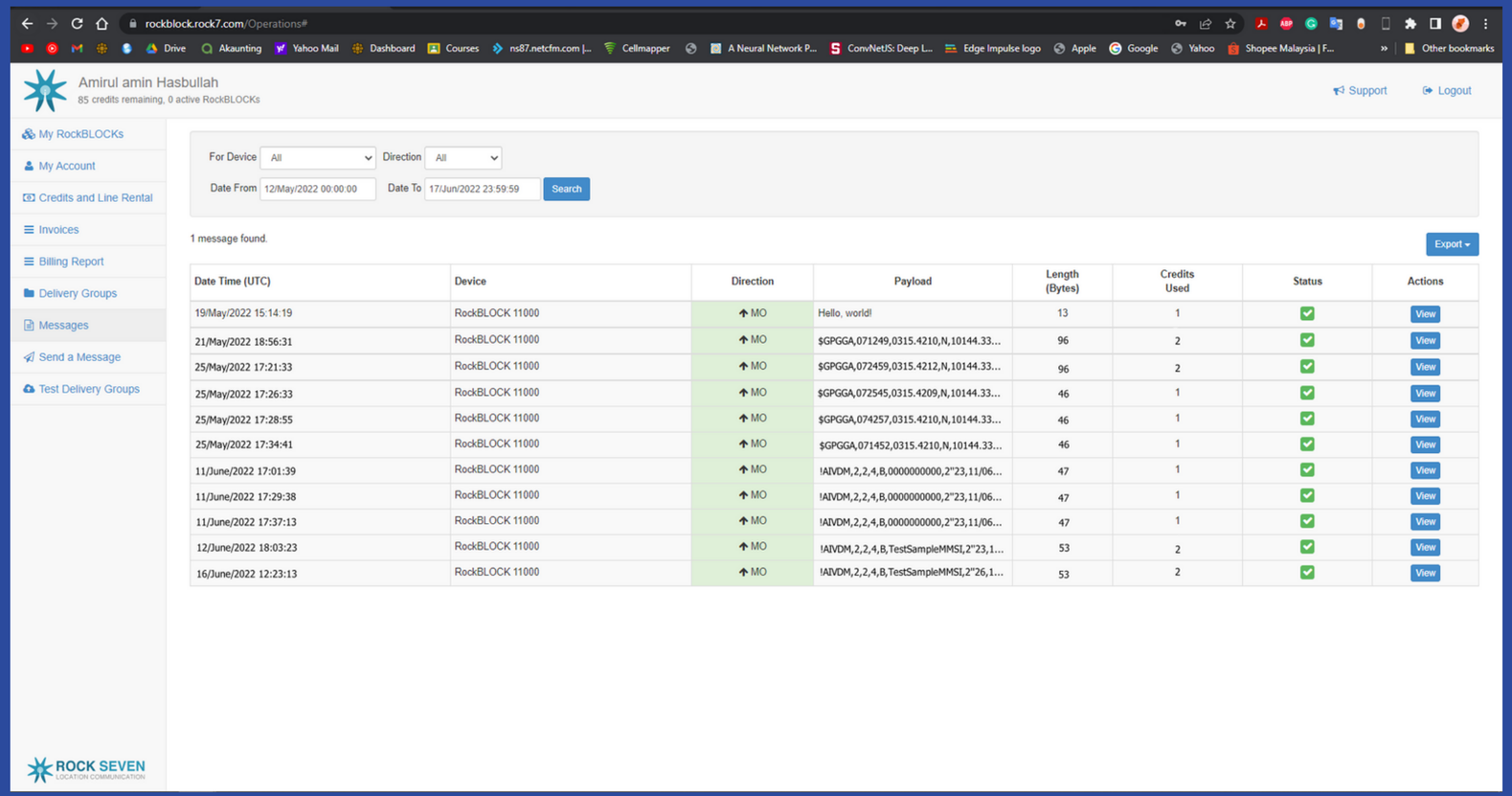
A1 created_at

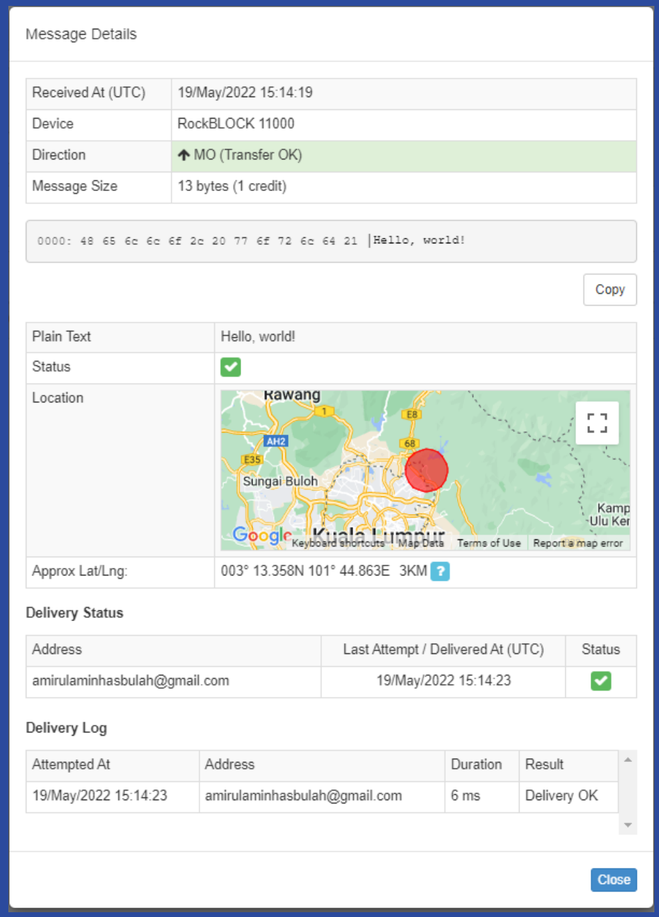
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	created_a	timestam	mmsi	msg_type	latitude	longitude	speed	course	heading	rot	imo	name	call_sign	flag	draught	ship_and_	length	width	eta	destinatic	status	maneuver	accuracy	to_bow	to_stern	to_port	to_starbo	collection_type	
2	2022-01-0	2022-01-0	6.67E+08	3	7.382017	115.6434	8.8	69.5	79	0				SL							0	0	0					satellite	
3	2022-01-1	2022-01-1	3.11E+08	3	15.00976	119.6384	16.1	350.7	350	3				BM							0	0	0					terrestrial	
4	2022-01-1	2022-01-1	3.06E+08	3	2.549142	105.0612	12.4	206.9	210	-12				AG							0	0	1					satellite	
5	2022-01-0	2022-01-0	2.11E+08	3	14.23484	119.6252	1.8	235	166	5				DE							3	0	0					terrestrial	
6	2022-01-0	2022-01-0	6.67E+08	3	7.0843	108.9172	8.1	90.6	80	0				SL							0	0	0					satellite	
7	2022-01-0	2022-01-0	3.2E+08	3	3.337112	104.3677	9.3	135.6	125	16				KY							0	0	0					satellite	
8	2022-01-1	2022-01-1	3.13E+08	3	22.24872	114.6818	8.2	66.6	67	0				BZ							0	0	0					terrestrial	
9	2022-01-0	2022-01-0	6.67E+08	3	15.11455	119.5499	8.6	16.9	15	0				SL							0	0	0					terrestrial	
10	2022-01-1	2022-01-1	2.71E+08	3	22.14077	114.871	15.9	103.4	100	-9				TR							0	0	1					terrestrial	
11	2022-01-1	2022-01-1	5.67E+08	3	4.193333	103.7448	15.8	157	164	127				TH							0	0	1					terrestrial	
12	2022-01-0	2022-01-0	4.47E+08	3	19.3898	119.2994	14.5	224.9	223	5				KW							0	0	1					satellite	
13	2022-01-1	2022-01-1	2.58E+08	3	2.341413	104.977	13.3	206	209	0				NO							0	0	1					satellite	
14	2022-01-1	2022-01-1	3.13E+08	2	6.476098	112.8621	8.1	357.6	6	0				BZ							0	0	1					satellite	
15	2022-01-1	2022-01-1	3.04E+08	3	3.263343	105.2193	14.9	201.4	198	-3				AG							0	0	1					satellite	
16	2022-01-1	2022-01-1	2.11E+08	3	15.92383	119.4957	21	355	2	0				DE							0	0	1					terrestrial	
17	2022-01-1	2022-01-1	3.13E+08	2	6.132597	112.8715	8.6	0.6	3	0				BZ							0	0	1					satellite	
18	2022-01-1	2022-01-1	5.68E+08	3	5.363405	103.5851	11.2	142.8	150	0				TH							8	0	0					satellite	
19	2022-01-1	2022-01-1	2.71E+08	3	22.24855	114.6939	16.2	120.3	119	-3				TR							0	0	1					terrestrial	
20	2022-01-0	2022-01-0	6.67E+08	3	7.213617	112.9887	8.9	89	93	0				SL							0	0	0					satellite	
21	2022-01-1	2022-01-1	4.04E+08	3	15.35752	119.2029	14.4	192.5	195	0				SA							0	0	0					terrestrial	
22	2022-01-1	2022-01-1	3.06E+08	3	2.712025	105.1444	12.3	209.9	210	-15				AG							0	0	1					satellite	
23	2022-01-0	2022-01-0	6.67E+08	3	11.47508	118.3438	8.8	13.1	13	0				SL							0	0	0					satellite	
24	2022-01-0	2022-01-0	6.67E+08	3	7.200233	111.5027	8.8	93.8	104	127				SL							0	0	0					satellite	
25	2022-01-0	2022-01-0	2.11E+08	3	14.05702	119.4567	9.3	122	106	-18				DE							0	0	0					terrestrial	
26	2022-01-1	2022-01-1	5.08E+08	3	7.007627	115.313	15.4	220.2	218	0				BN							0	0	0					satellite	
27	2022-01-1	2022-01-1	3.13E+08	2	5.494755	112.8647	7	3.6	6	0				BZ							0	0	1					satellite	
28	2022-01-0	2022-01-0	2.11E+08	3	14.1575	119.5683	11.7	80	71	-17				DE							0	0	0					terrestrial	
29	2022-01-0	2022-01-0	2.58E+08	3	14.38278	119.4951	10.1	94	88	0				NO							0	0	0					terrestrial	
30	2022-01-0	2022-01-0	2.11E+08	3	14.07183	119.5473	9.5	80	68	-14				DE							0	0	0					terrestrial	
31	2022-01-0	2022-01-0	2.11E+08	3	14.29067	119.7087	2	232	181	0				DE							3	0	0					terrestrial	
32	2022-01-1	2022-01-1	3.13E+08	2	5.383912	112.8622	7.5	358.8	3	0				BZ							0	0	1					satellite	
33	2022-01-1	2022-01-1	6.22E+08	3	2.08045	105.0505	0.2	239	358	0				DJ							1	0	1					satellite	
34	2022-01-0	2022-01-0	5.67E+08	3	2.208028	104.9009	8.4	276.7	286	0				TH							0	0	0					satellite	
35	2022-01-1	2022-01-1	5.43E+08	3	1.843123	104.5879	3	282	511	-128				NU							0	0	1					satellite	
36	2022-01-1	2022-01-1	3.06E+08	3	1.943807	104.7569	12.6	208.5	209	11				AG							0	0	1					satellite	
37	2022-01-1	2022-01-1	3.19E+08	3	4.79314	104.5445	13.6	172.7	172	0				KY							0	0	1					satellite	

DATA TRANSMISSION

TRANSMITTING TO SATELLITE

- *Data is transmitted every 5 minutes (charging the onboard super capacitor)*
- *Saved to cloud*

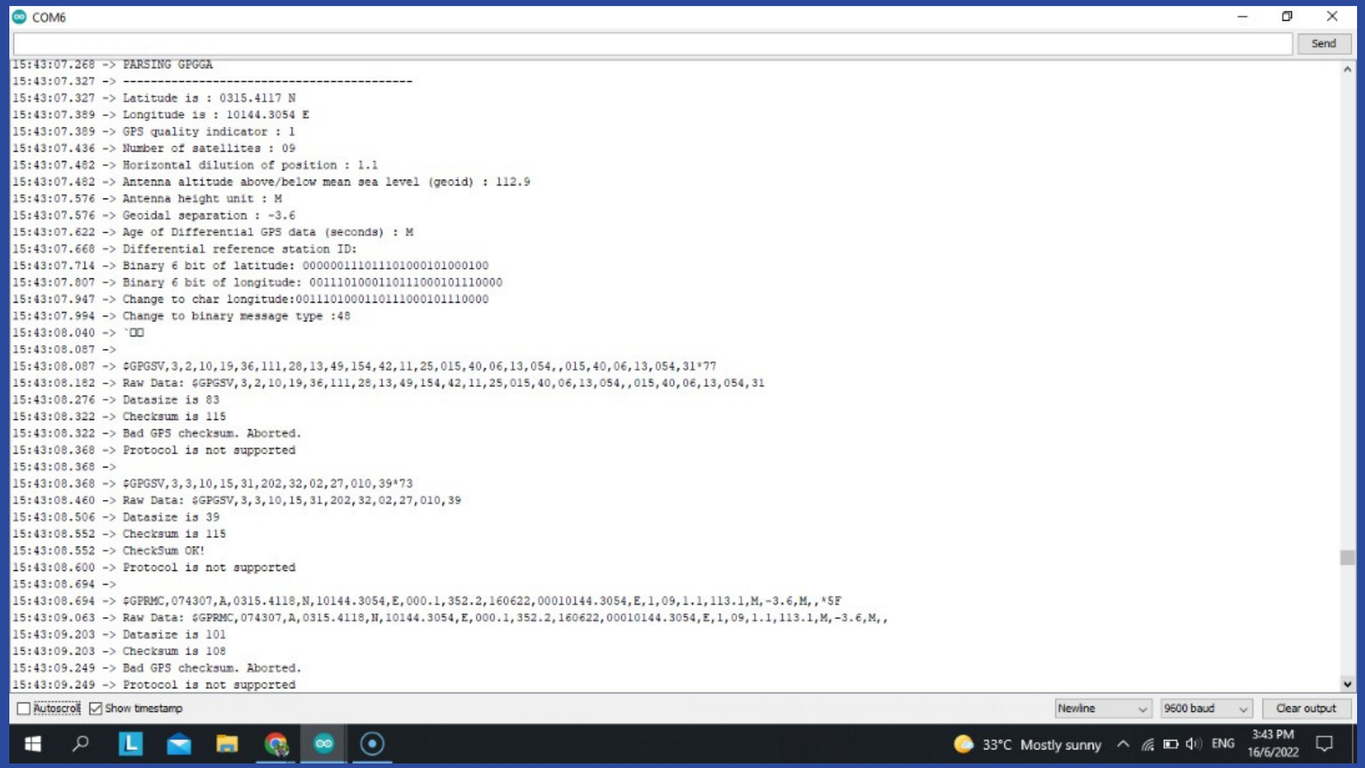




DATA TRANSMISSION

TRANSMITTING TO LOCAL TRANSCEIVER

- *Data is transmitted every 1 second (1 Hz pulse of GPS) in raw format (direct information) or AIVMM format (need 6-bit decoding)*
- *Saved to local ground station*



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