LOOK MUM FLYING CAN

ESERO-Poland CanSat 2021 Competition Team

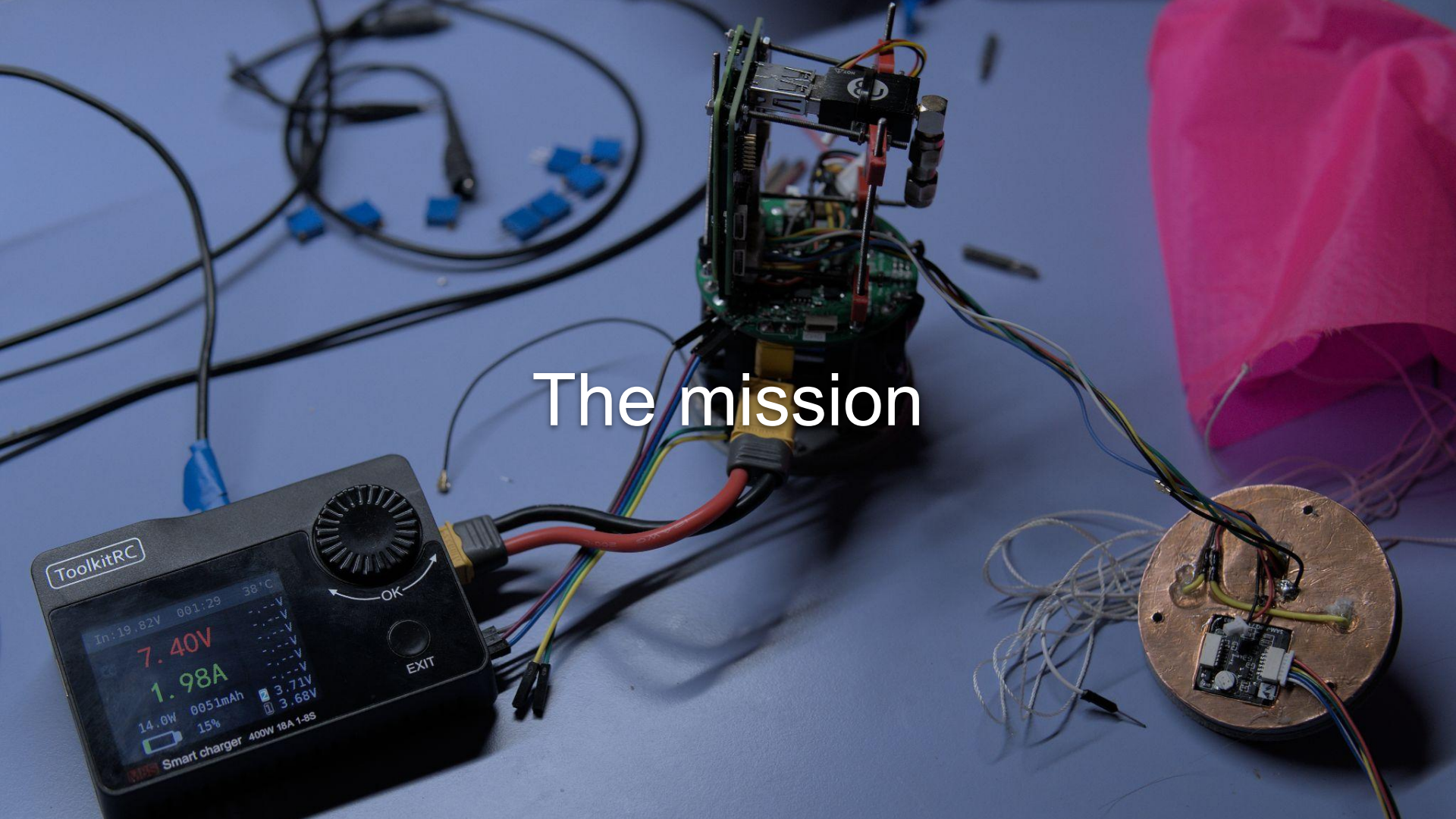
The Team

Miłosz
Project Lead

Jakub
Software Engineer

Mikołaj
Backend Engineer

Sebastian
AERO Engineer


ToolkitRC
OK
EXIT
7.40V
1.98A
0051mAh
14.0W
15%
3.71V
3.68V
Smart charger 400W 18A 1-8S

The mission

Objectives

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- create first SDR-based CanSat platform
- data relay / range extender device for rescue workers
- create tiny linux-based platform capable of operating in space
- improve aerospace safety by expanding range of ADS-B system

Mission description

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Primary mission

- Monitor thermal performance (SDR, BAT, STM32, RPi, ext)
- Measure current altitude (pressure)

Secondary mission

- Relay ADS-B data
- Localize Cospas-Sarsat beacon
- Over-the-horizon propagation test

Mission description

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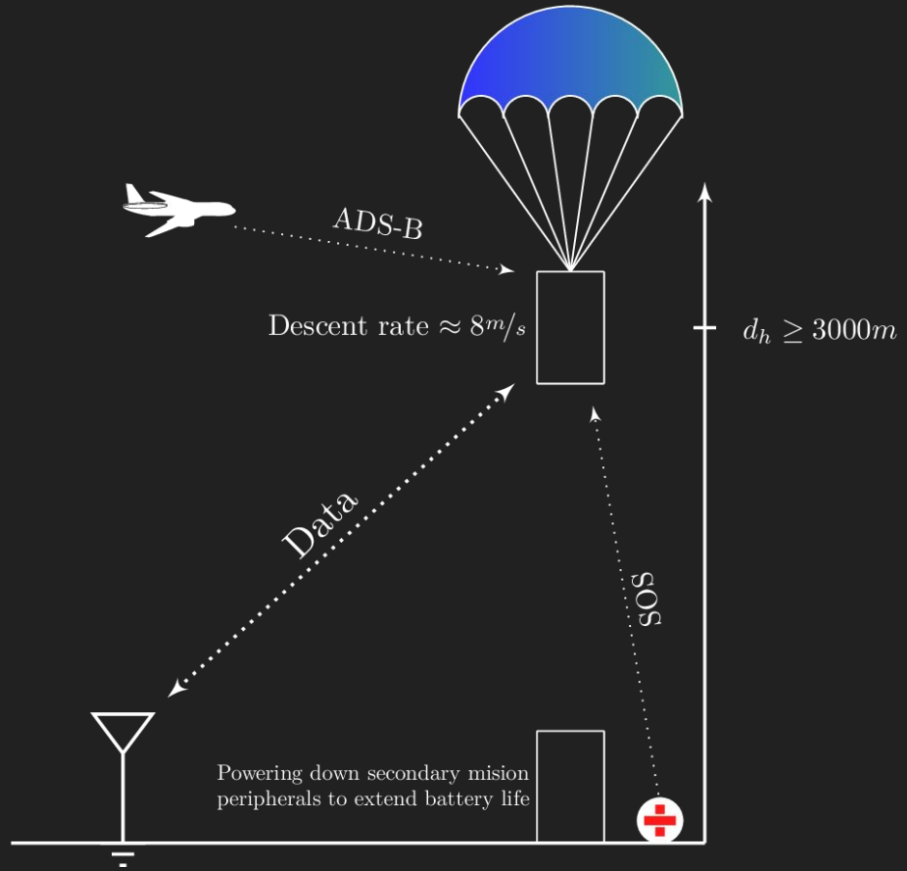
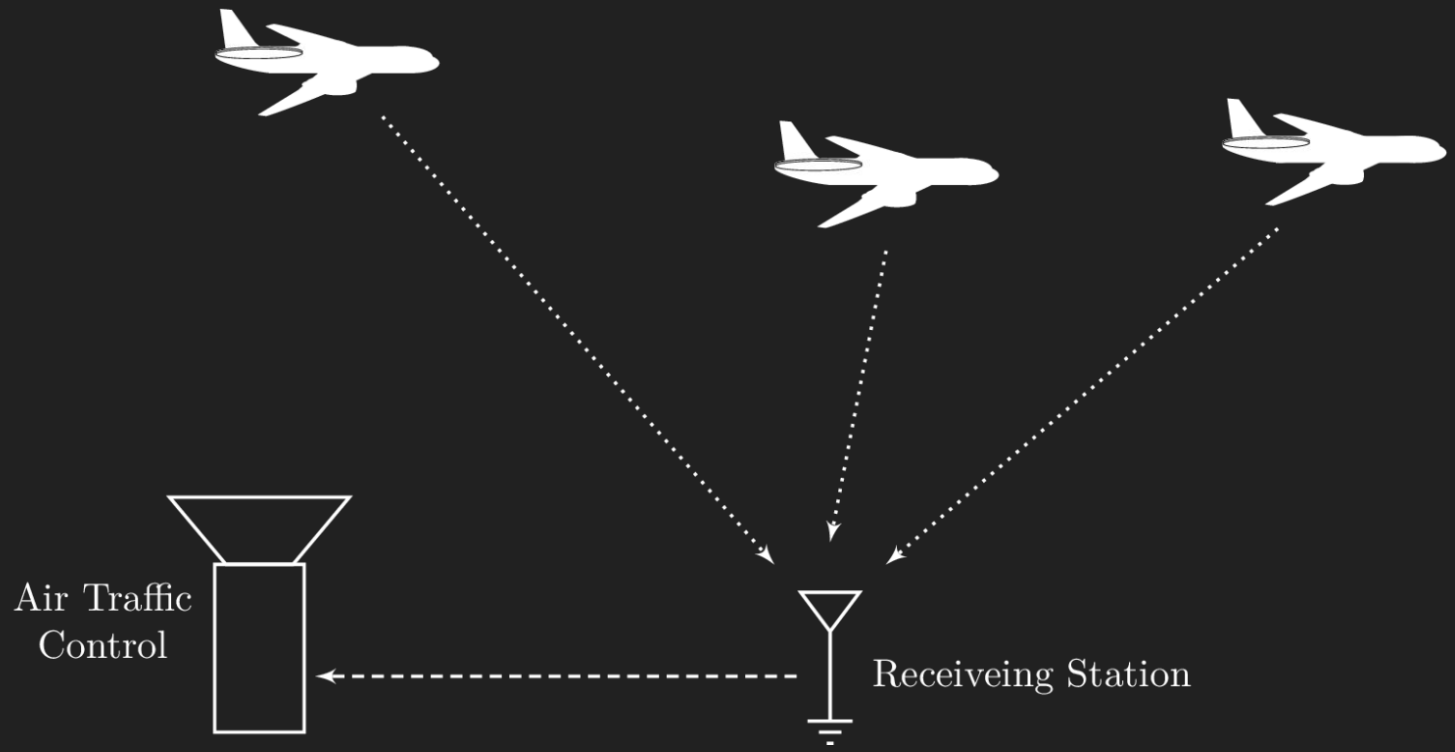


Secondary mission / ADS-B



Secondary mission / ADS-B

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Limited ADS-B coverage  ADS-B satellite platform

Our Cansat aims to increase worldwide ADS-B coverage, by working as a signal relay station

Secondary mission / Cospas-Sarsat

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We also planned to integrate our CanSat to Cospas-Sarsat system but due to the clock generator IC failure we were unable to receive data.


Hardware & Software

CanSat's modules & subsystems

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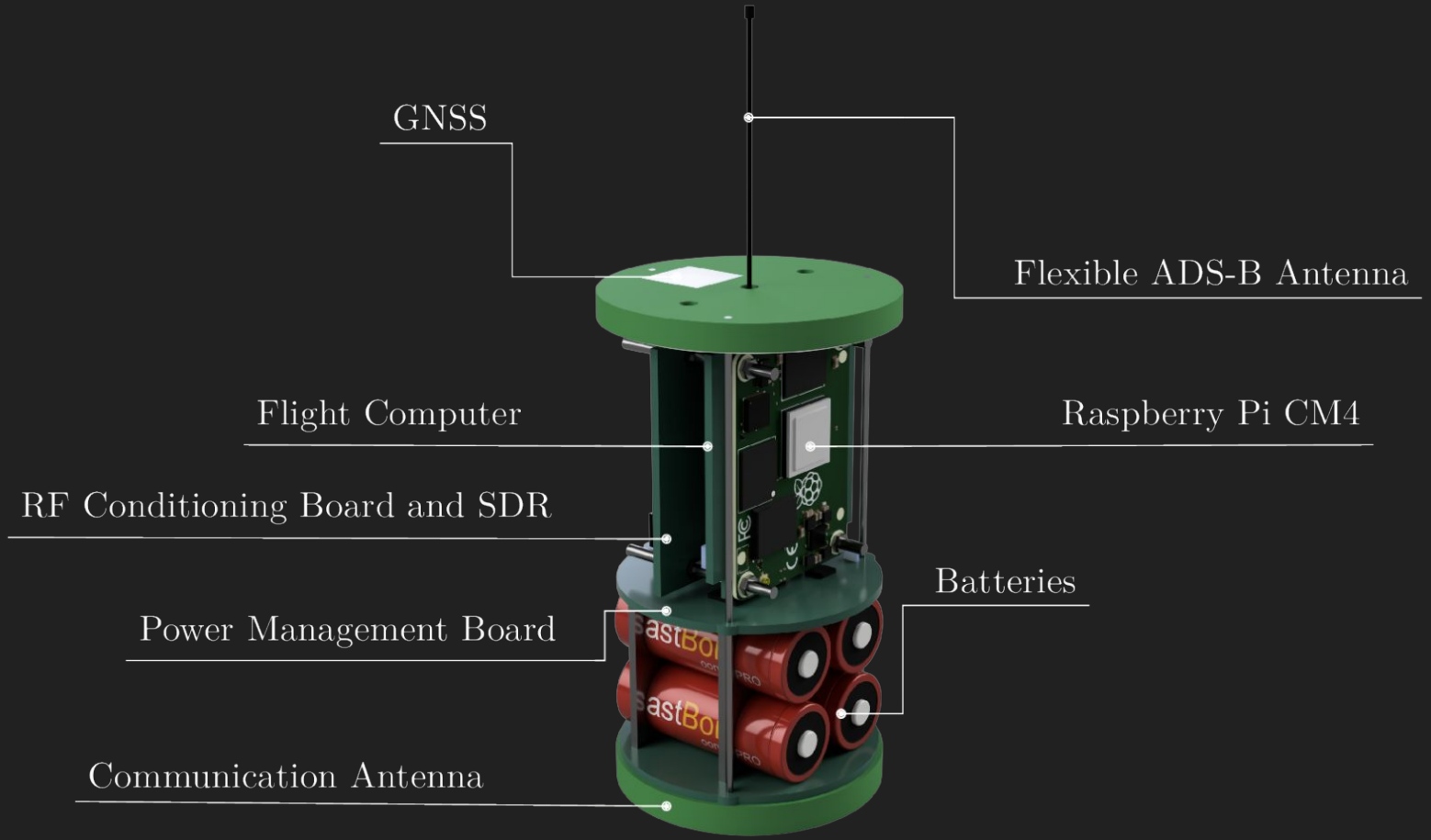

CanSat's modules & subsystems

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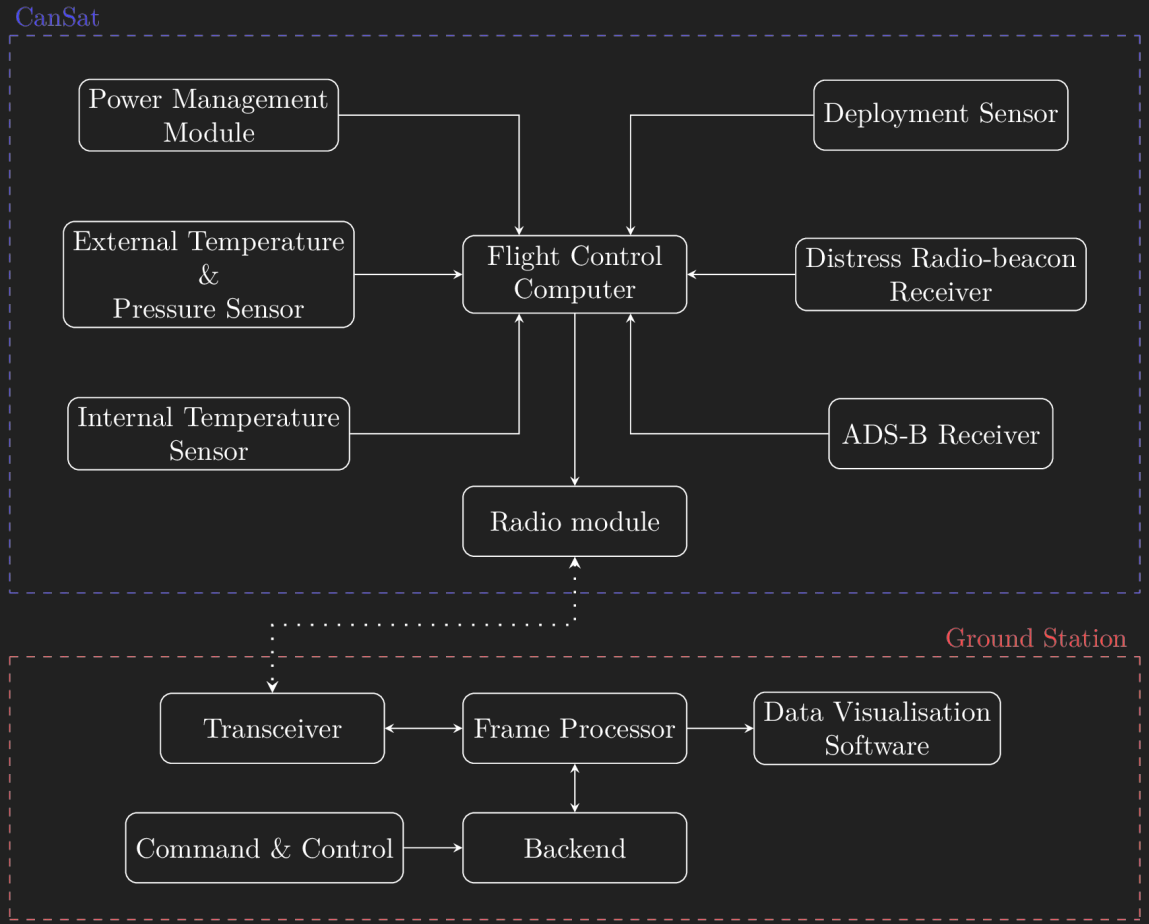


```c
while (1)
{
    State_OnFrameStart(&state);

    printf("--- Frame %d ---\n", state.frameNumber);

    switch (state.phase) {
        case Phase_Armed:
            ExecuteTasks_Armed();
            break;
        case Phase_Liftoff:
            ExecuteTasks_Liftoff();
            break;
        case Phase_Deployed:
            ExecuteTasks_Deployed();
            break;
        case Phase_Recovery:
            ExecuteTasks_Recovery();
            break;
        case Phase_Off:
            Shutdown();
            break;
        case Phase_Test:
            break;
    }

    State_OnFrameEnd(&state, true);
}
```

```
pressureTriggers += pressureTrigger();

if ((pressureTriggers >= 10 && HAL_GetTick() - startTick > 600000)) {
    RPi_SetPower(&rpi, 0);
    Buzzer_PlayMelody(&buzzer, &melody_barka);
    State_ChangePhase(&state, Phase_Recovery);
}
```

```
uint8_t pressureTrigger() {
    pressureVariation[2] = pressureVariation[1];
    pressureVariation[1] = pressureVariation[0];
    pressureVariation[0] = lastPressure - telemetry_sensor.pressure;

    double pressureVariationAwg = (pressureVariation[2] + pressureVariation[1] + pressureVariation[0]) / 3;
    double pressureToGround = (lastPressure + telemetry_sensor.pressure) / 2 - groundPressure;

    lastPressure = telemetry_sensor.pressure;

    if (pressureVariationAwg < 0.01 && pressureVariationAwg > -0.01)
        return 0;

    if (pressureVariationAwg < 30.0 && pressureVariationAwg > -30.0)
        return pressureToGround < 1500.0 && pressureToGround > -1500.0

    return 0;
}
```

```
Initializing HAL
[8353] Initializing peripherals
> SD: OK
> BMP280: OK
> INA3221: OK
> DS18B20: OK (7)
> LoRa: OK
[9270] Init completed!
[9270] SYS STATUS: OK
...
```


Atc radar view
18°
19°
20°
52°
51°
50°
N
5.41V 3.29V 7.05V
0.4A 0.2A 0.3A
1366
PCB SDR ENV ENV RPI
01:12:11Z 44.2C 31.3C 20.2C 22.8C 60.1C

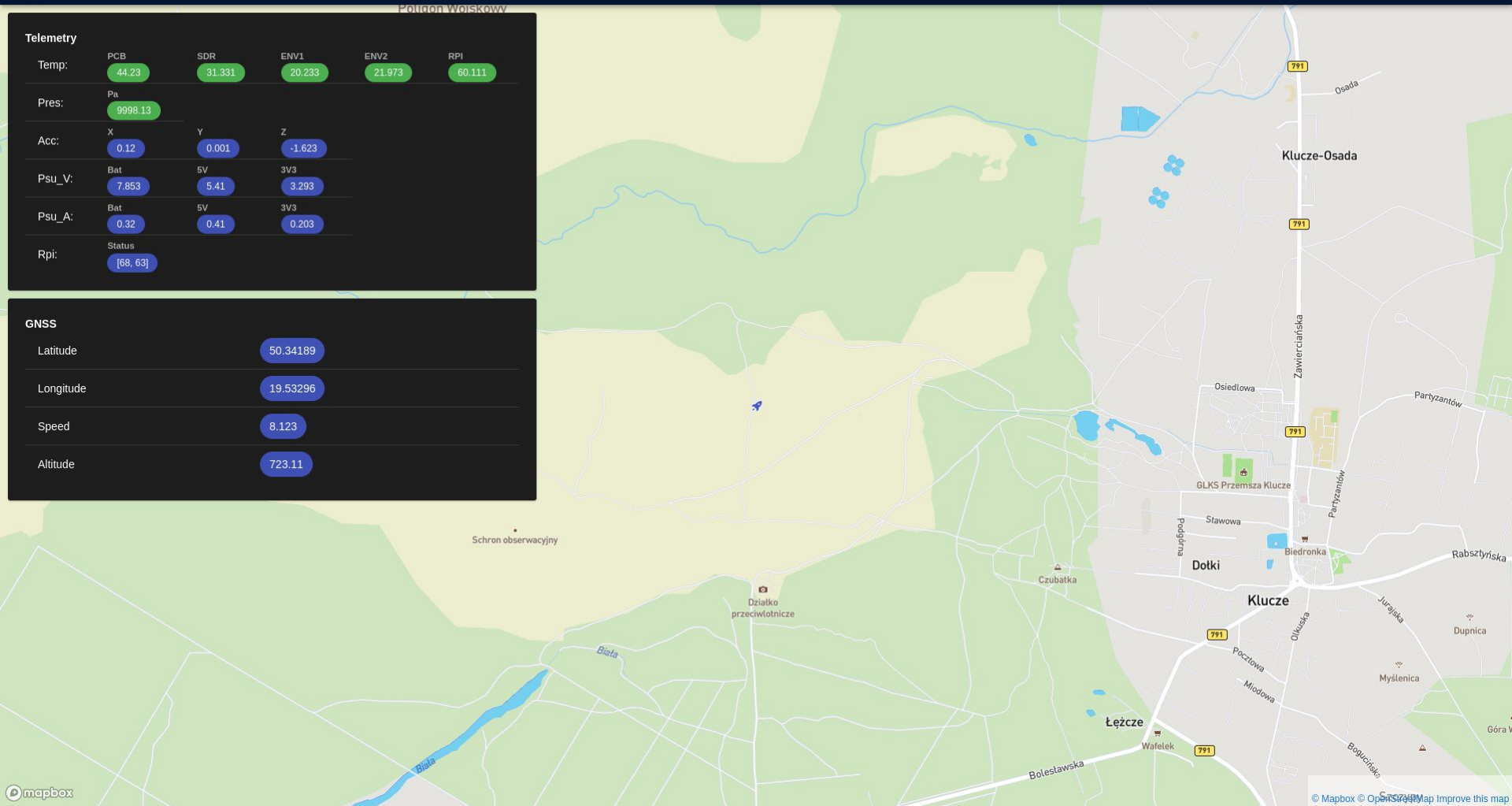

Atc board view
ICAO CALL IDENT ALTI SPD AZIM V/R VSRC TTPK
40621b INOP INOP 38000m INOP INOP INOP INOP 1366
40621d KLM1023 4 0 38000m 375.00kt 243.98 -2304ft/min TAS 1366
51af9 INOP INOP INOP INOP INOP INOP INOP 1366

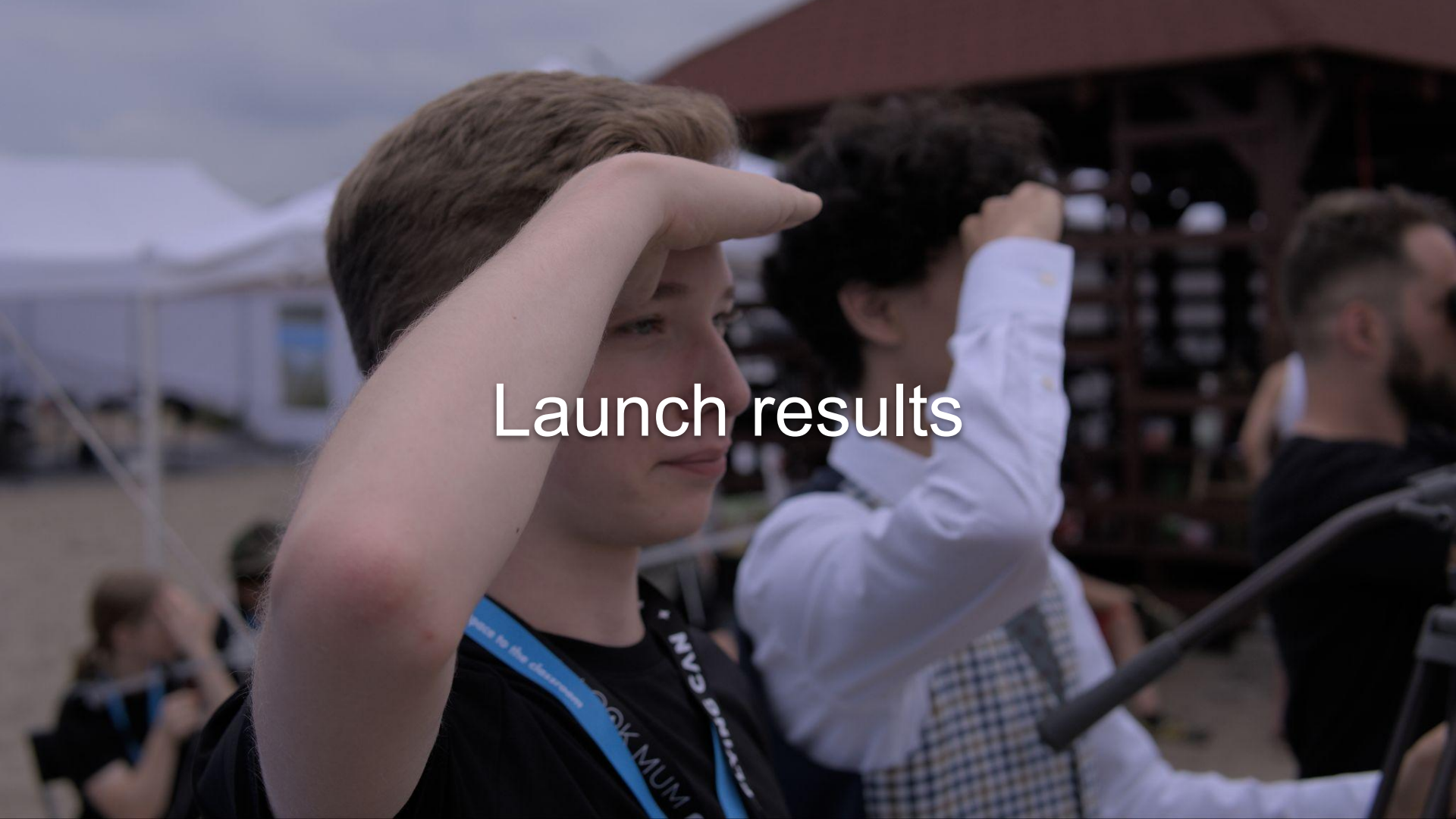
Telemetry

Temp:	PCB	SDR	ENV1	ENV2	RPI
	44.23	31.331	20.233	21.973	60.111
Pres:	Pa				
	9998.13				
Acc:	X	Y	Z		
	0.12	0.001	-1.623		
Psu_V:	Bat	5V	3V3		
	7.853	5.41	3.293		
Psu_A:	Bat	5V	3V3		
	0.32	0.41	0.203		
Rpi:	Status				
	[68, 63]				

GNSS

Latitude	50.34189
Longitude	19.53296
Speed	8.123
Altitude	723.11




Launch results

Launch results

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- primary mission systems operational
- radio link established
- recovery system worked as predicted
- SBC did not boot - suspected voltage transient during power on

Additional data gathering

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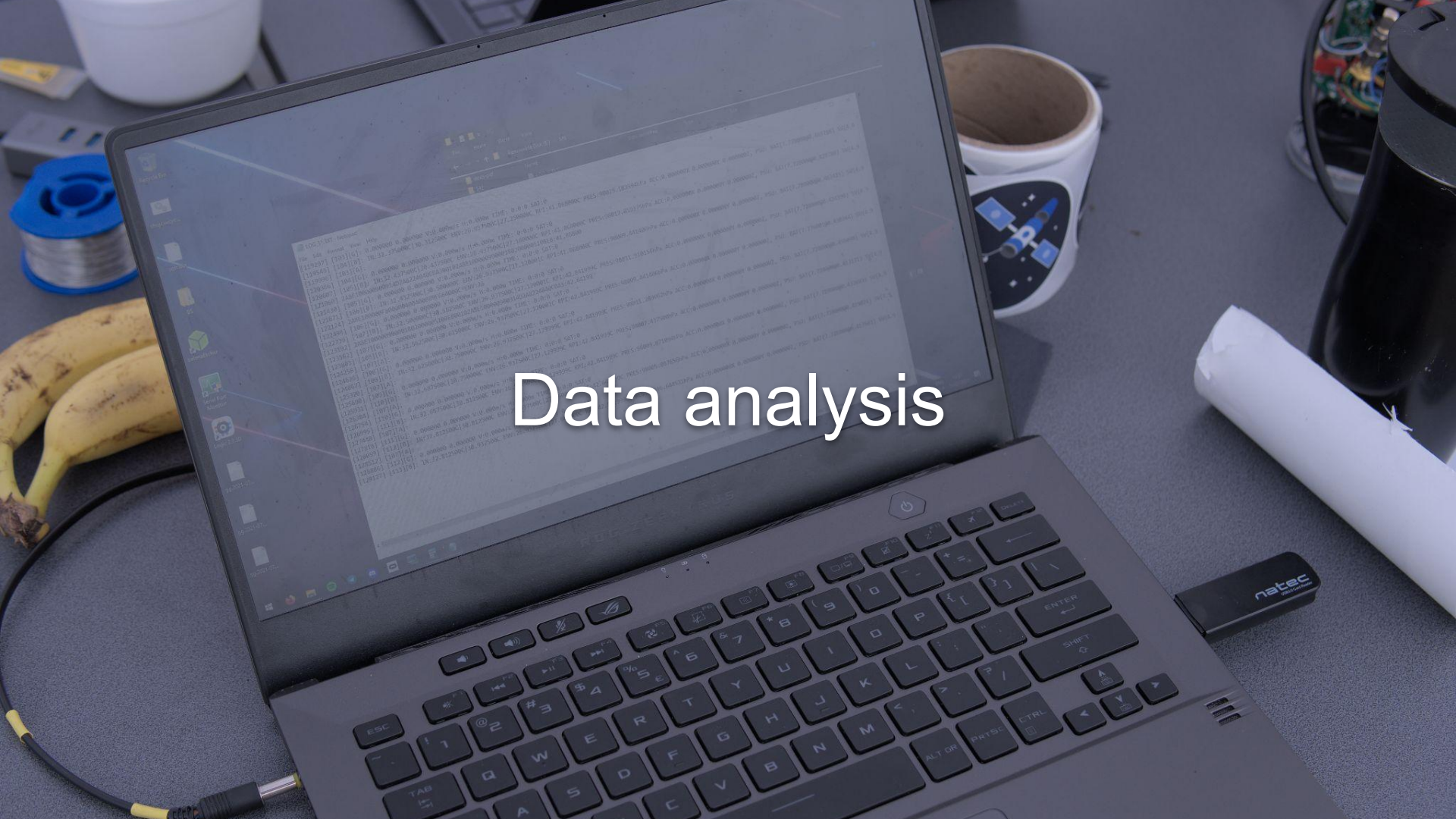
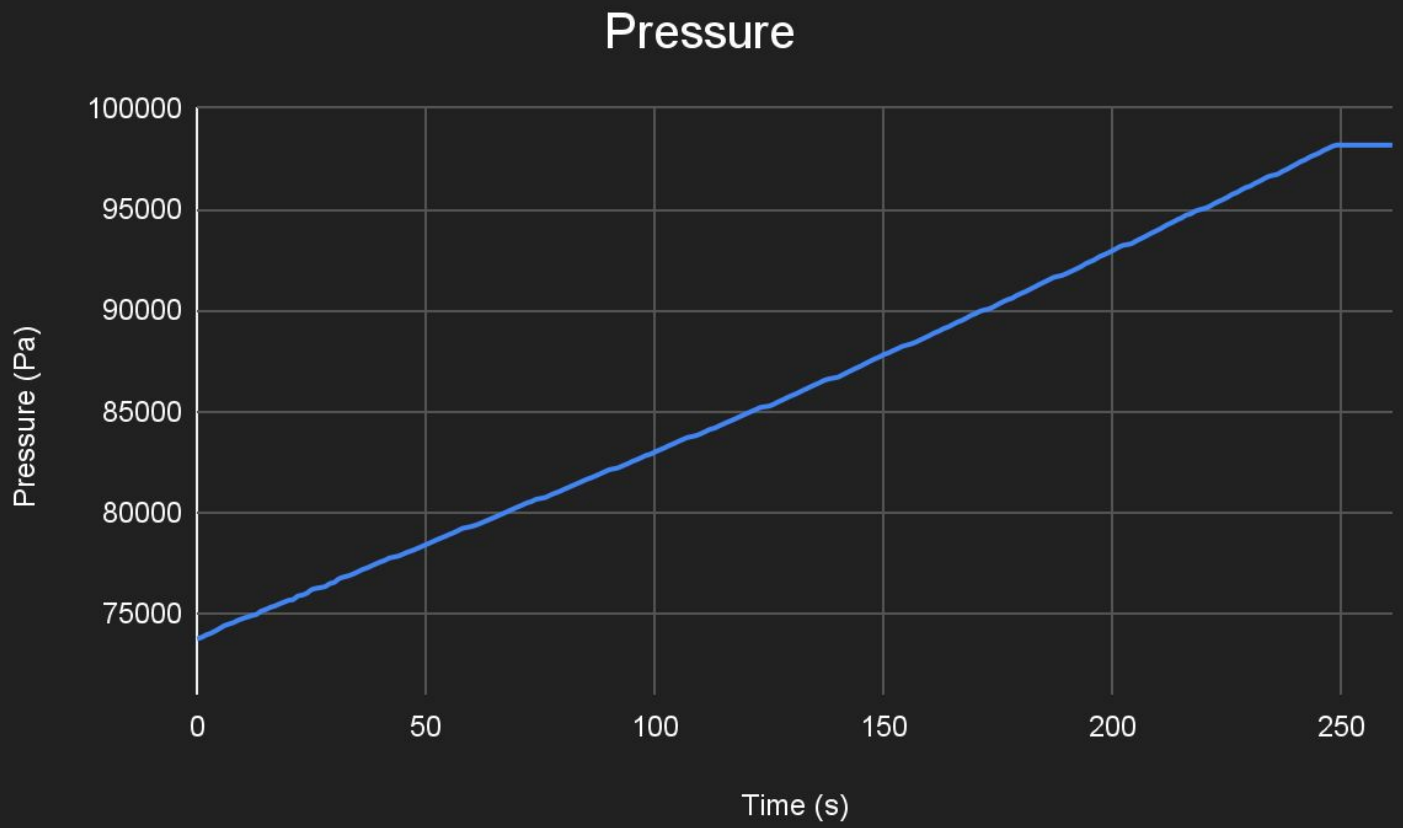

Data analysis

Data analysis



Data analysis

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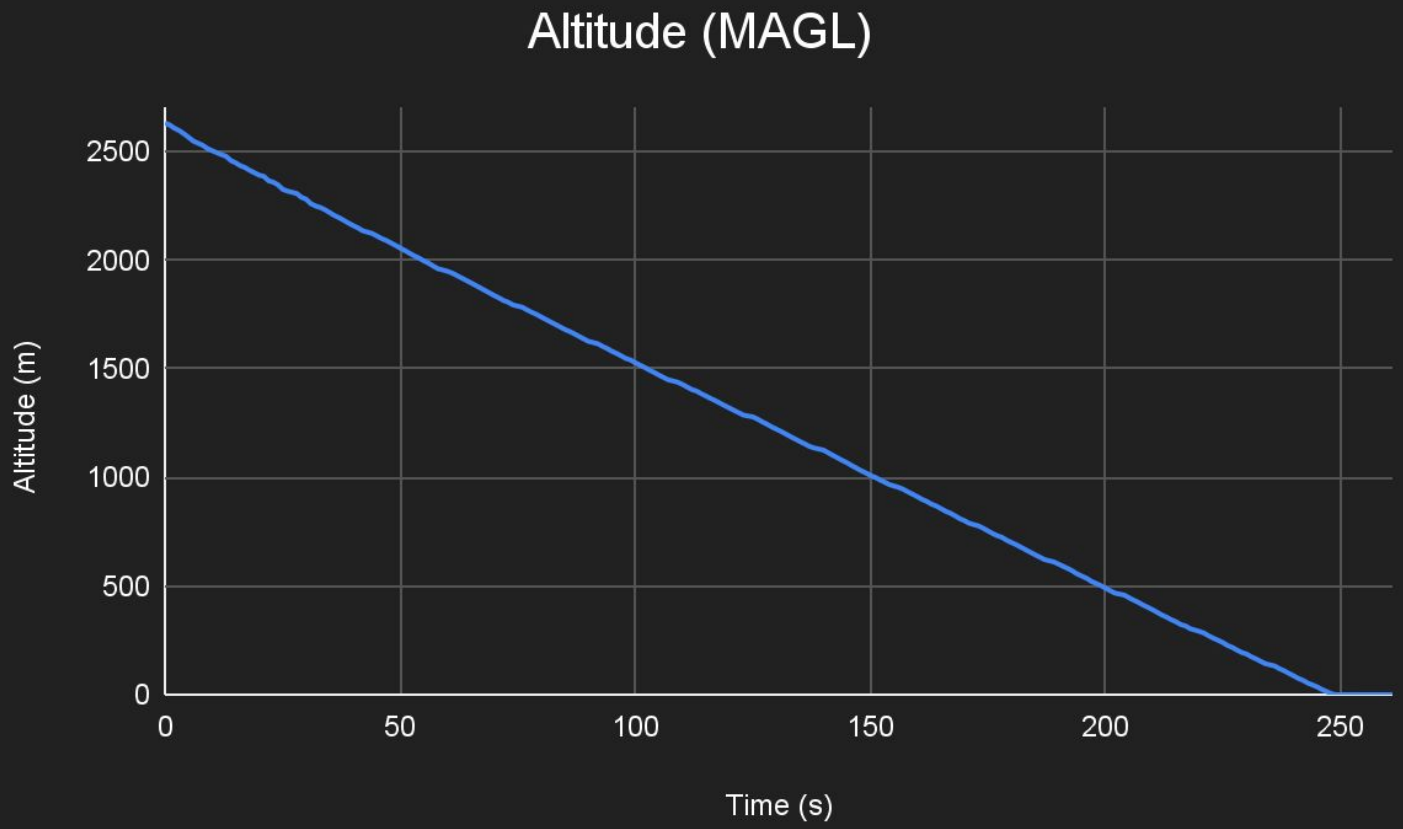
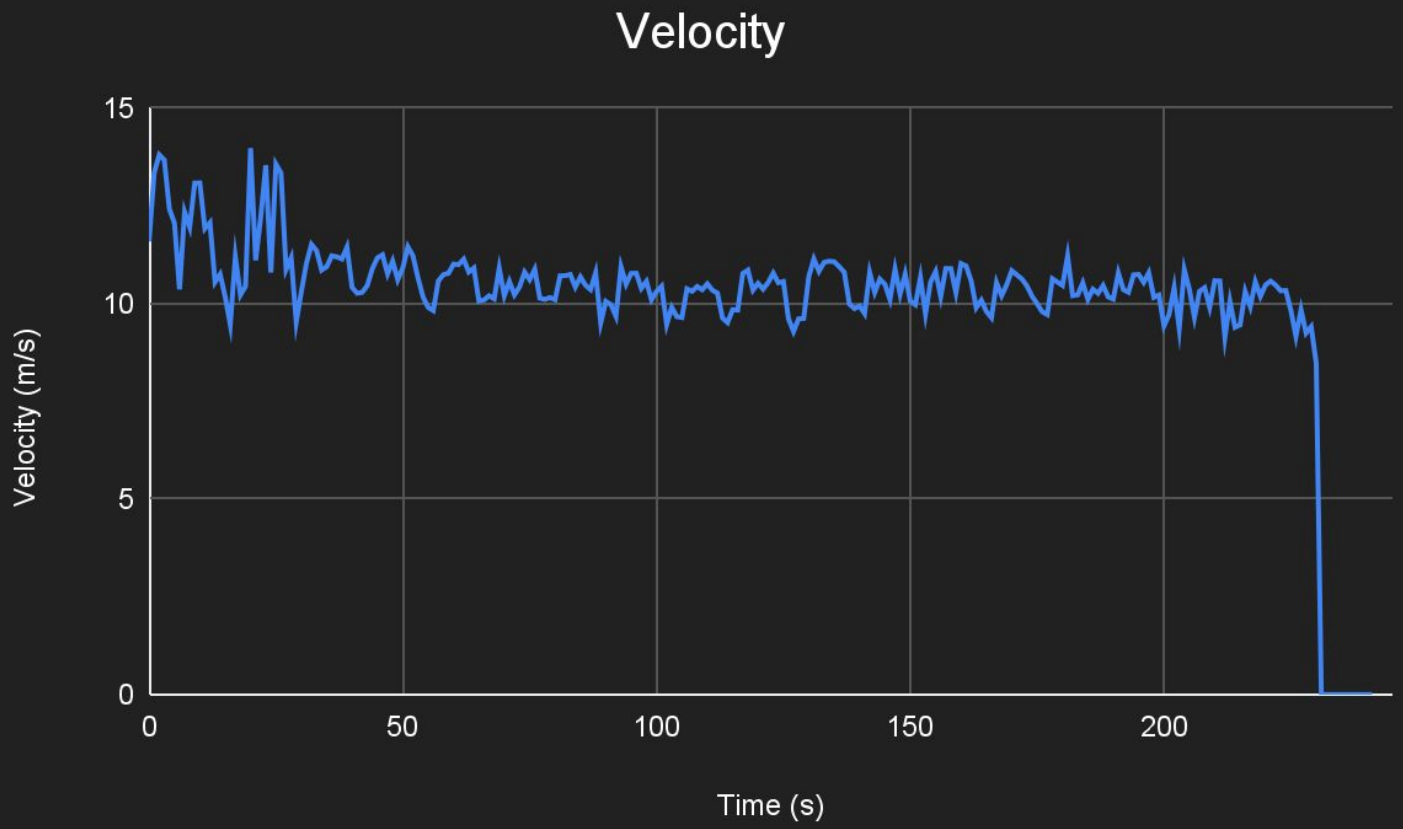
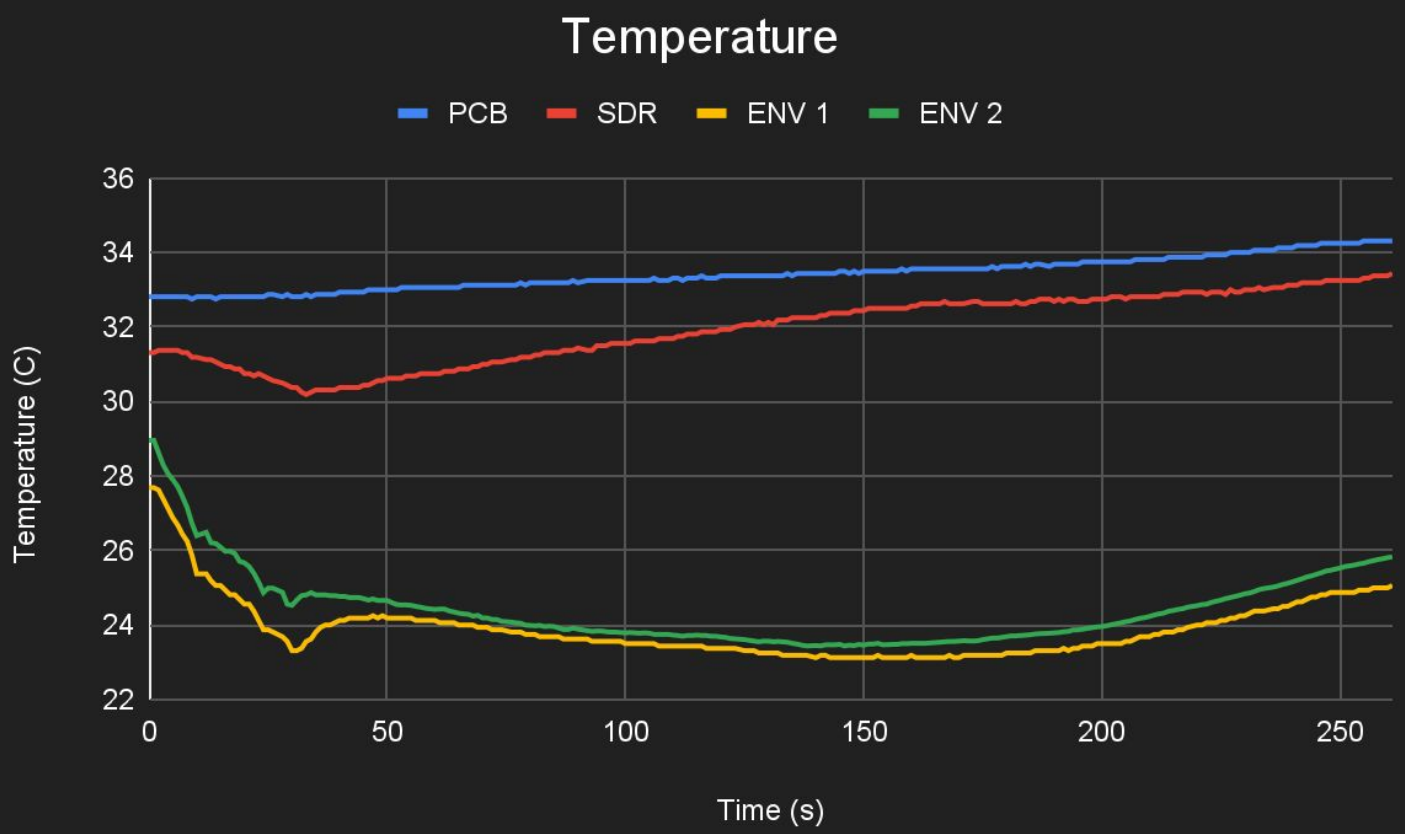


Data analysis



Data analysis (system idle)



Data analysis (system operational)

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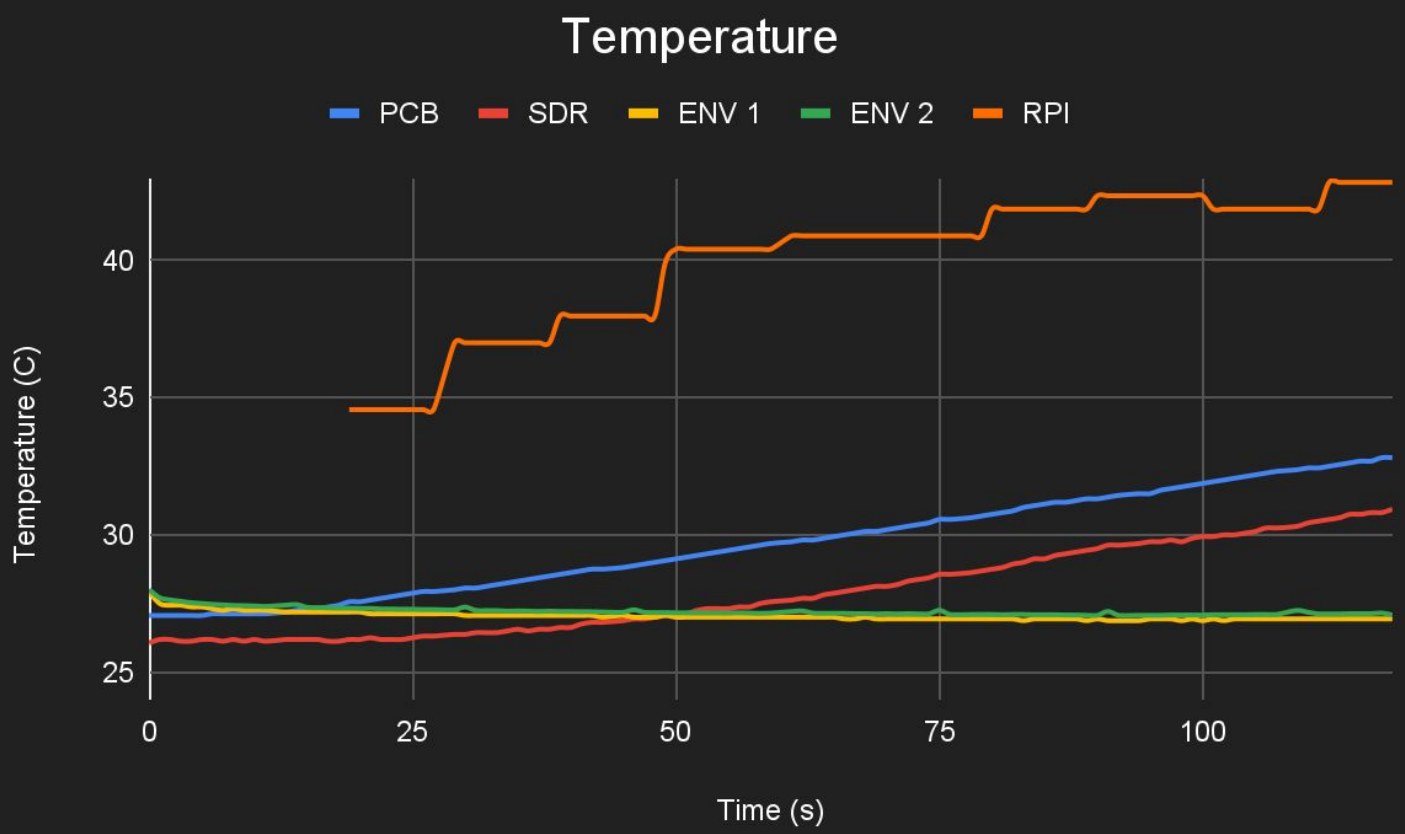

Data analysis

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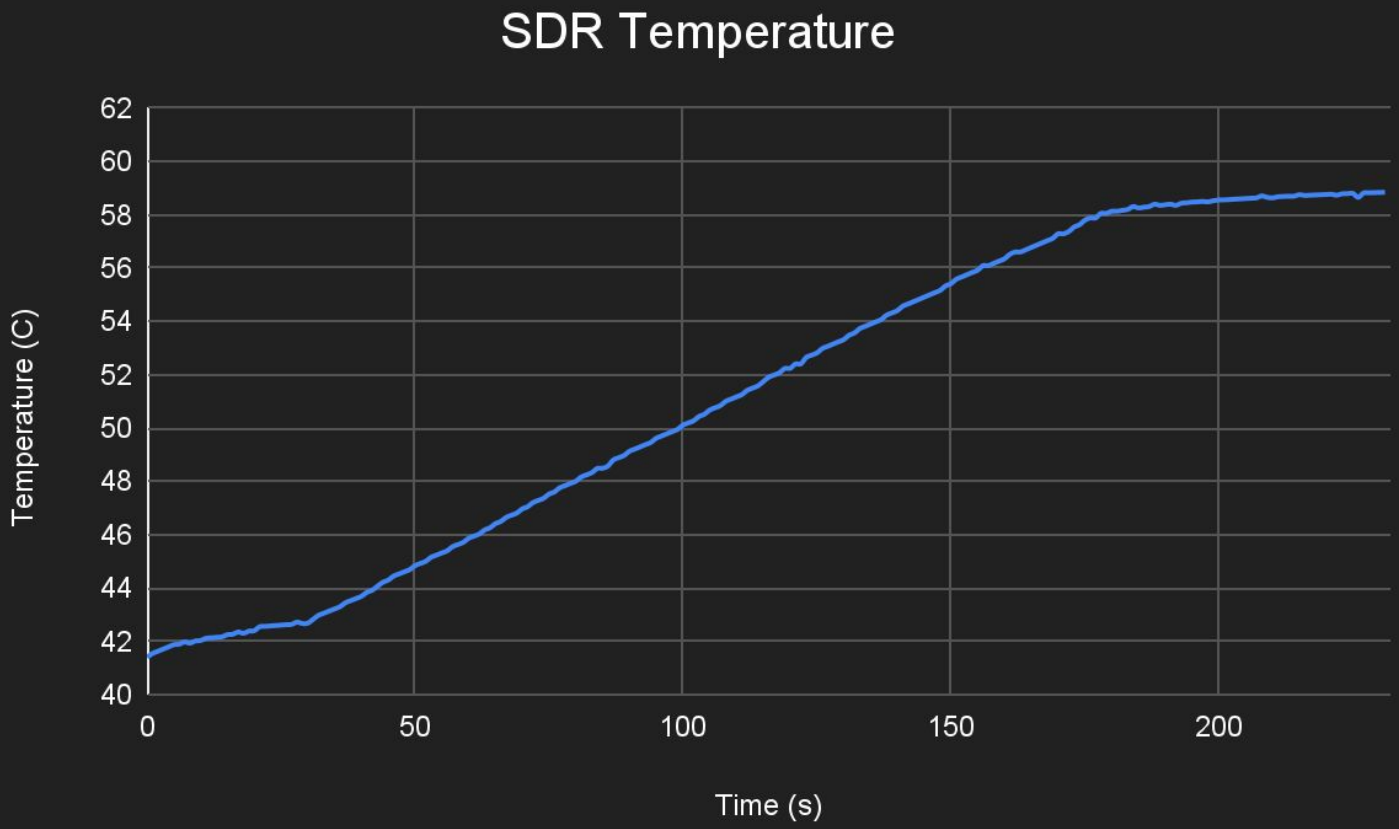
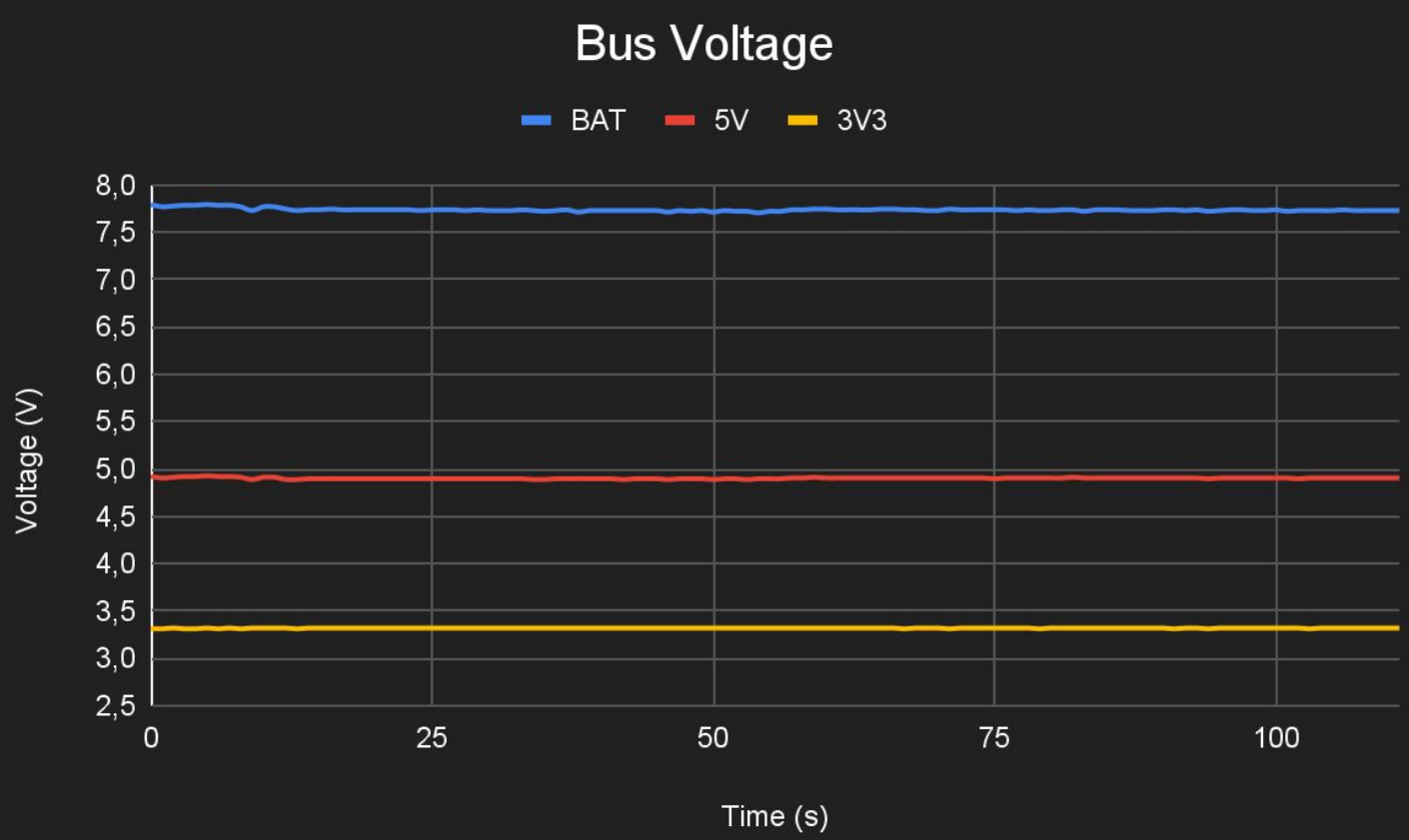
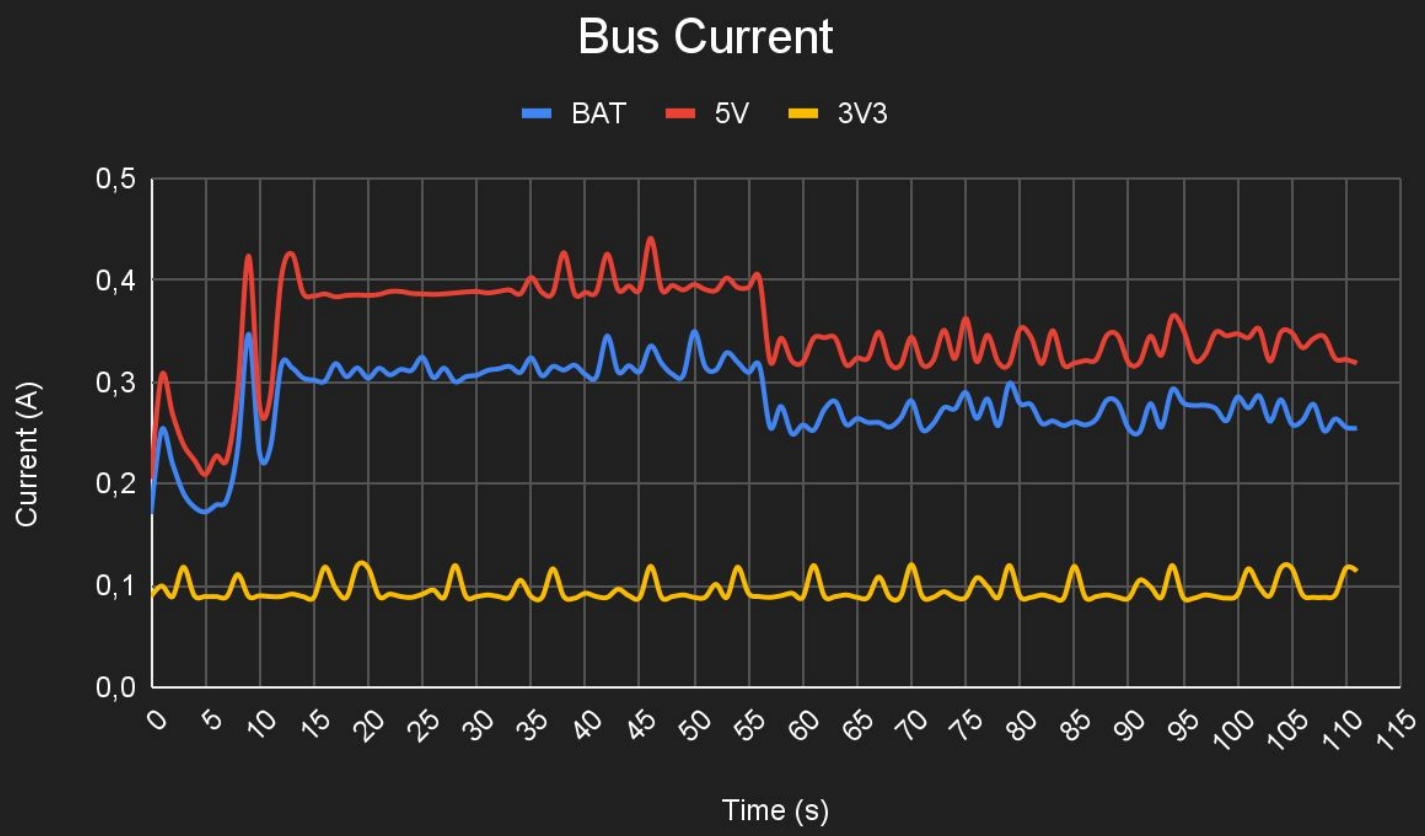


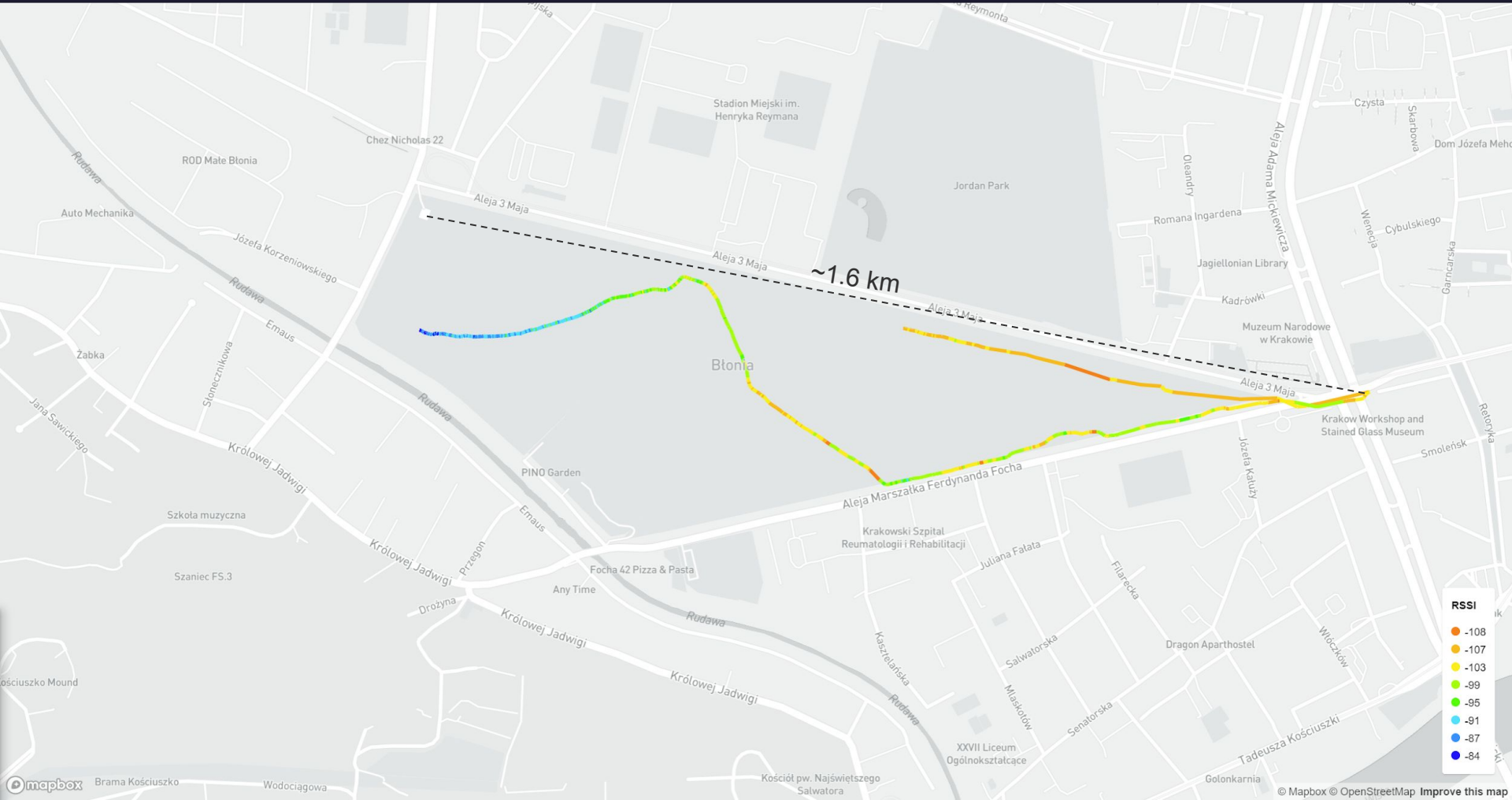
Data analysis



Data analysis



LookMumFlyingCan Receiver Test




Mission result

Mission result

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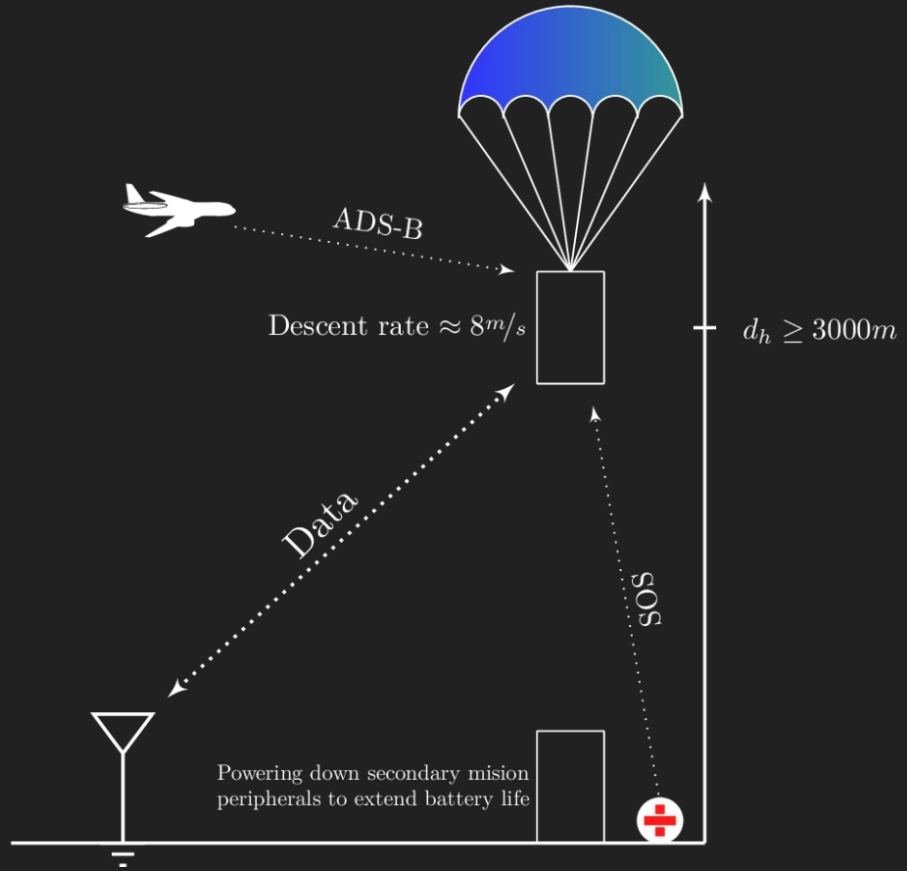
(PARTIAL) SUCCESS

Mission result



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CanSat's modules & subsystems

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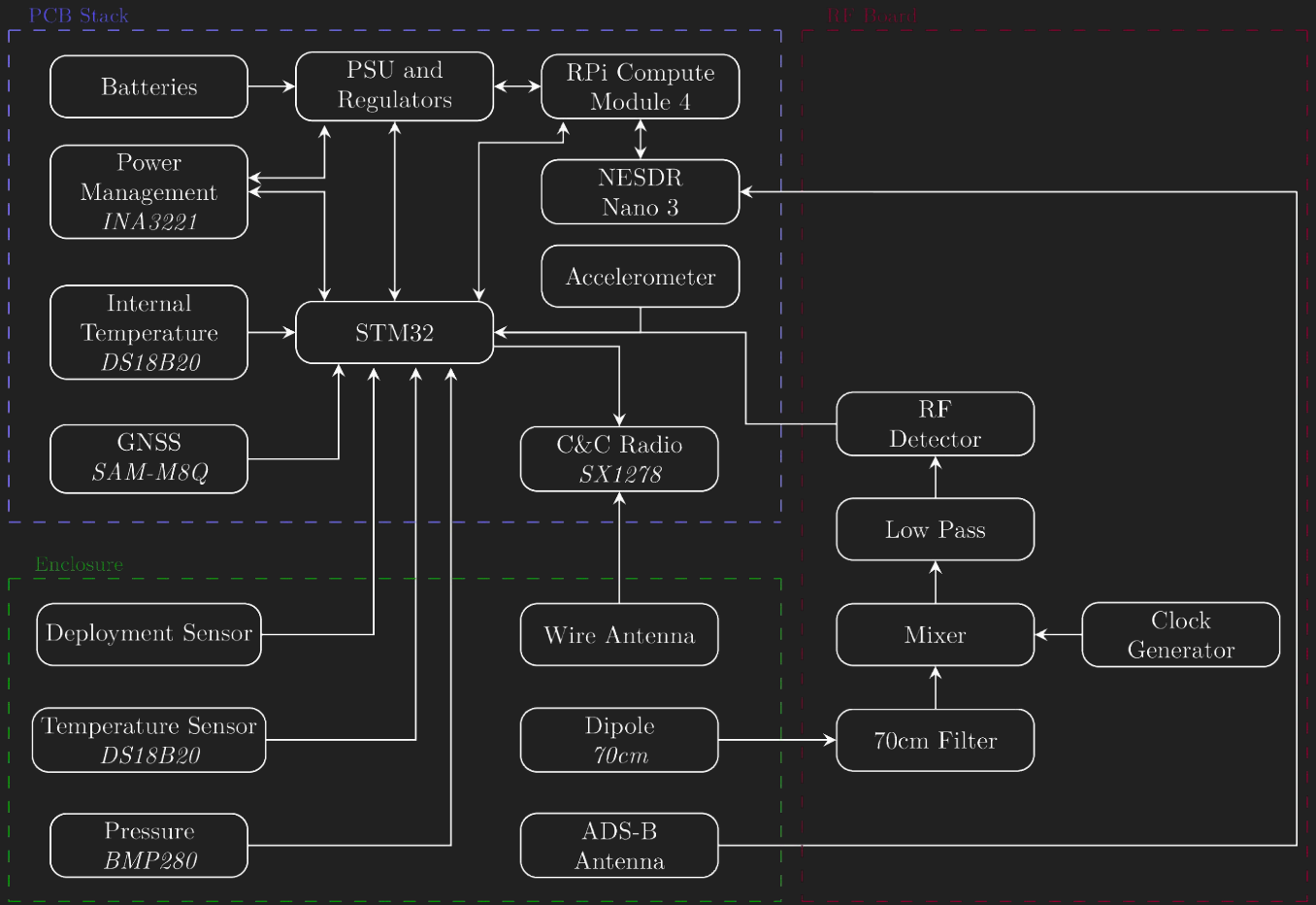

Secondary mission / ADS-B

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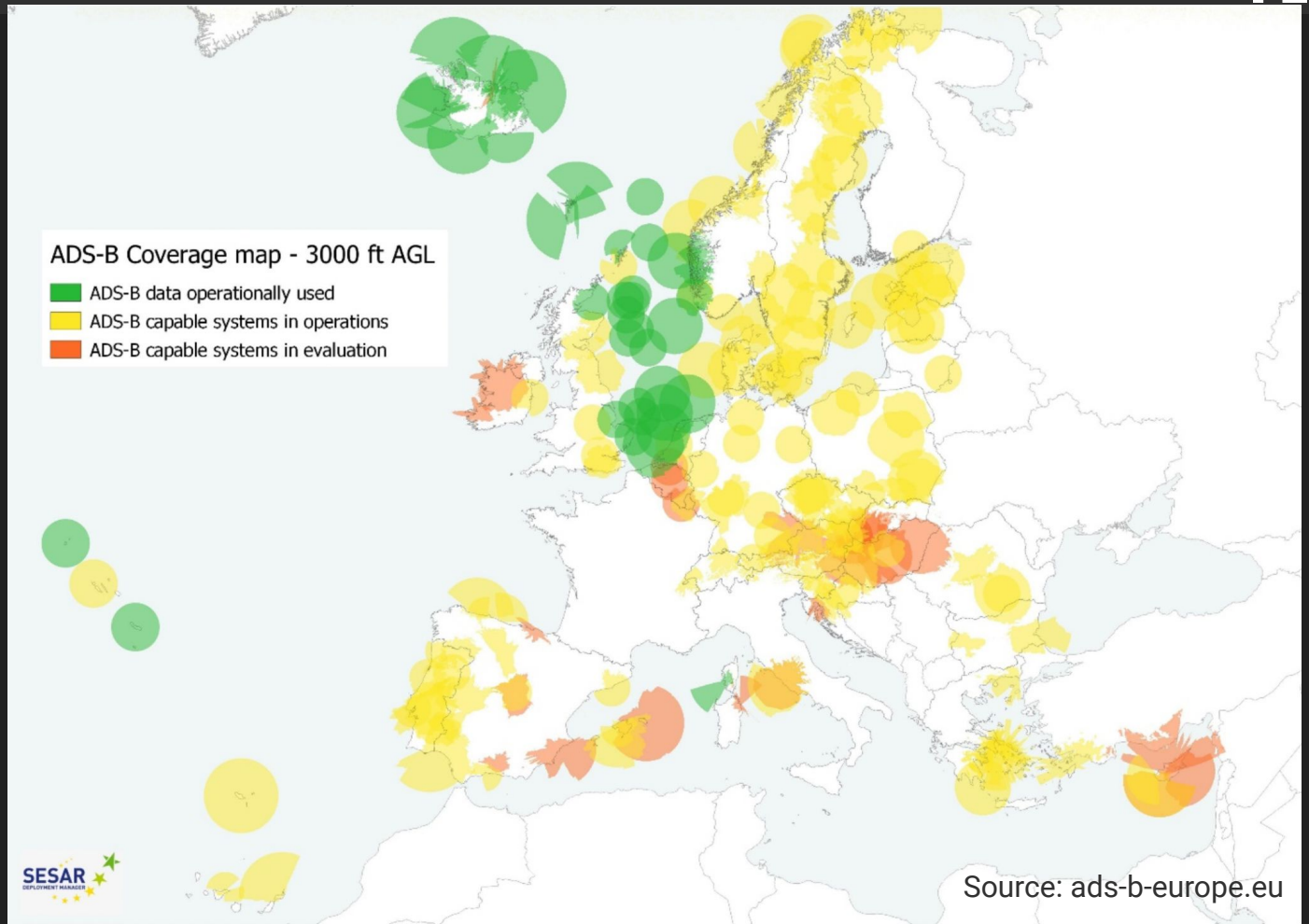
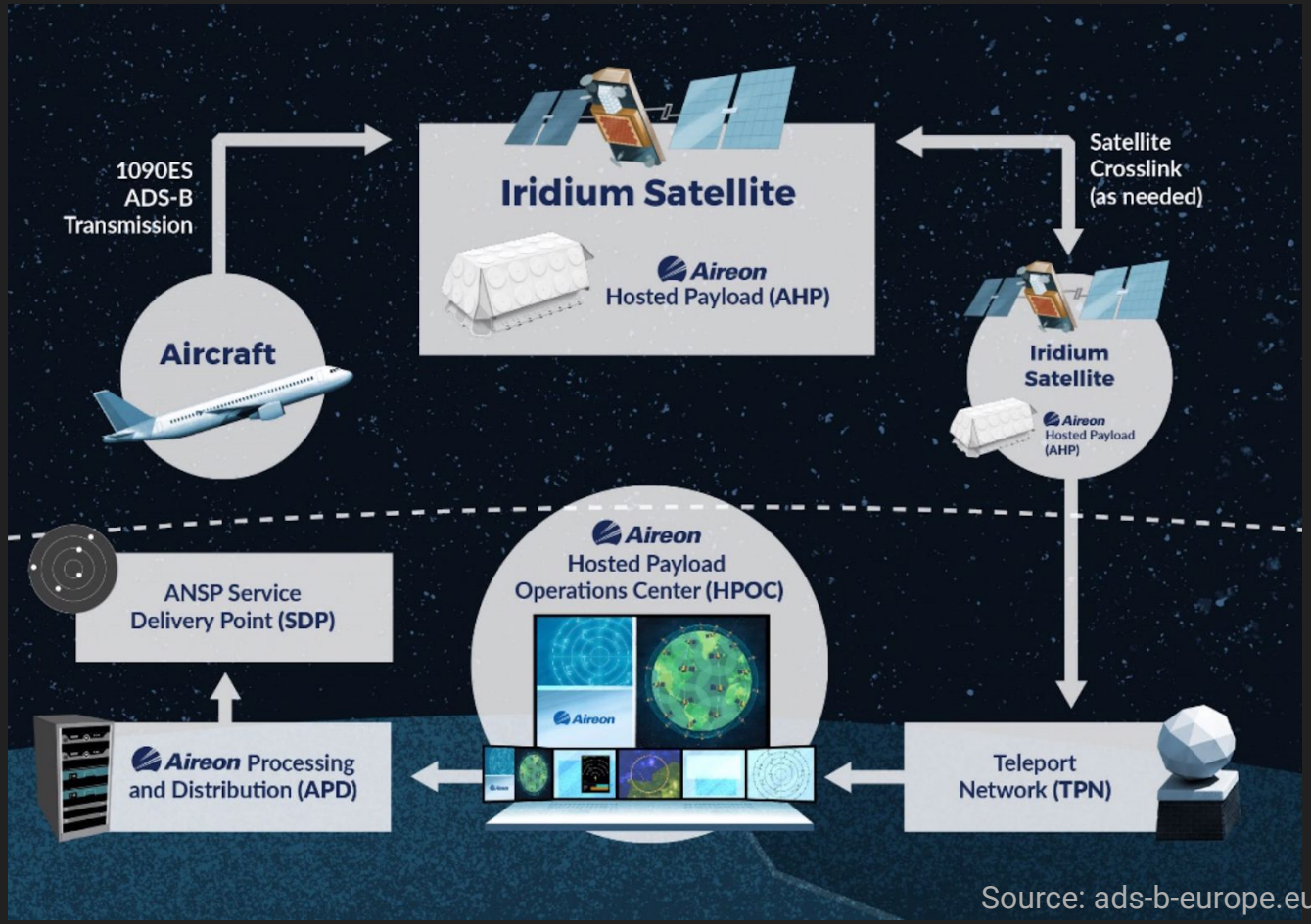


Secondary mission / ADS-B



Source: ads-b-europe.eu

Example log


```
[109292] 2A5E100000C5A4F700102A8E10000099000180200000 5108EB7.080000
[109667] [94][G]: 0.000000 0.000000 V:0.000m/s H:0.000m TIME: 0:0:0 SAT:0
[109908] [95][B]: IN:31.812500C|29.875000C ENV:26.937500C|27.080000C RPI:42.355000C PRES:98011.687500hPa ACC:0.000000X
0.000000Y 0.000000Z, PSU: BAT(7.736001@0.419512) 5V(4.904000@0.326341) 3V3(3.320000@0.088800) SDR:DI FLAG:127
[110361] 2A8E100000990001802000005108EB00102A8E100000990001802000005108EB42.35500
[110731] [95][G]: 0.000000 0.000000 V:0.000m/s H:0.000m TIME: 0:0:0 SAT:0
[110993] [96][B]: IN:31.875000C|29.937500C ENV:26.875000C|27.080000C RPI:42.355000C PRES:98010.617188hPa ACC:0.000000X
0.000000Y 0.000000Z, PSU: BAT(7.720000@0.480000) 5V(4.896000@0.364390) 3V3(3.312000@0.120000) SDR:DI FLAG:127
[111446] 2A8E100000900914D2A8224840CBA300C ENV:26
[111816] [96][G]: 0.000000 0.000000 V:0.000m/s H:0.000m TIME: 0:0:0 SAT:0
[112057] [97][B]: IN:31.937500C|29.937500C ENV:26.937500C|27.090000C RPI:41.868000C PRES:98012.054688hPa ACC:0.000000X
0.000000Y 0.000000Z, PSU: BAT(7.728000@0.458537) 5V(4.904000@0.351707) 3V3(3.320000@0.088800) SDR:DI FLAG:127
[112510] [96][A]:
[112880] [97][G]: 0.000000 0.000000 V:0.000m/s H:0.000m TIME: 0:0:0 SAT:0
[113121] [98][B]: IN:32.000000C|30.000000C ENV:26.875000C|27.090000C RPI:41.868000C PRES:98008.562500hPa ACC:0.000000X
0.000000Y 0.000000Z, PSU: BAT(7.736001@0.454146) 5V(4.904000@0.321463) 3V3(3.320000@0.088000) SDR:DI FLAG:127
[113574] 2A8E100000990001802000005108EB00102A8E100000990001802000005108EB41.86800
[113944] [98][G]: 0.000000 0.000000 V:0.000m/s H:0.000m TIME: 0:0:0 SAT:0
[114189] [99][B]: IN:32.062500C|30.000000C ENV:26.937500C|27.090000C RPI:41.868000C PRES:98008.230469hPa ACC:0.000000X
0.000000Y 0.000000Z, PSU: BAT(7.736001@0.454634) 5V(4.904000@0.326341) 3V3(3.320000@0.091200) SDR:DI FLAG:127
[114642] [98][A]:
[115012] [99][G]: 0.000000 0.000000 V:0.000m/s H:0.000m TIME: 0:0:0 SAT:0
[115253] [100][B]: IN:32.125000C|30.062500C ENV:26.937500C|27.090000C RPI:41.868000C PRES:98010.667969hPa ACC:0.000000X
0.000000Y 0.000000Z, PSU: BAT(7.728000@0.449268) 5V(4.904000@0.348780) 3V3(3.320000@0.089600) SDR:DI FLAG:127
[115706] 2A8E100000990001802000005108EB000C ENV:26
[116076] [100][G]: 0.000000 0.000000 V:0.000m/s H:0.000m TIME: 0:0:0 SAT:0
[116317] [101][B]: IN:32.187500C|30.125000C ENV:26.937500C|27.100000C RPI:41.868000C PRES:98009.312500hPa ACC:0.000000X
0.000000Y 0.000000Z, PSU: BAT(7.728000@0.429756) 5V(4.904000@0.345366) 3V3(3.320000@0.088000) SDR:DI FLAG:127
[116770] 2A8E10000090091161123EE35B2CA300102A8E100000990001802000005108EB:41.86800
```

Data analysis


```
*5d4ca2d468fe2f;
*a0000290805b7317e00c5e4cdaf9;
*5d4ca2d468fe2f;
*8d4ca2d4990cba8558400ca98692;
*8d4ca2d4f8230006004878dfa184;
*8d4ca2d4ea07e86ecd1c08a3c52b;
*8d4ca2d46013f1672437abfd1f92;
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*5d4ca2d468fe2f;
*8d4ca2d4990cb98538400b9ccd9f;
*8d4ca2d46013e1671a379716b9f7;
*0281823e18f693;
*a000023effdb7517bff45cfdf3c6;
*a000023e87d40d30b80000b2c747;
*2000023ed1aaa2;
*8d4ca2d4990cb98538400b9ccd9f;
*8d4ca2d4f8230006004878dfa184;
*8d4ca2d4e1149f00000000b7067e;
*8d4ca2d4990cb98538400c631dbb;
```