77.8%

Lab #7+ Mission Design

Systems Engineering / MBSE

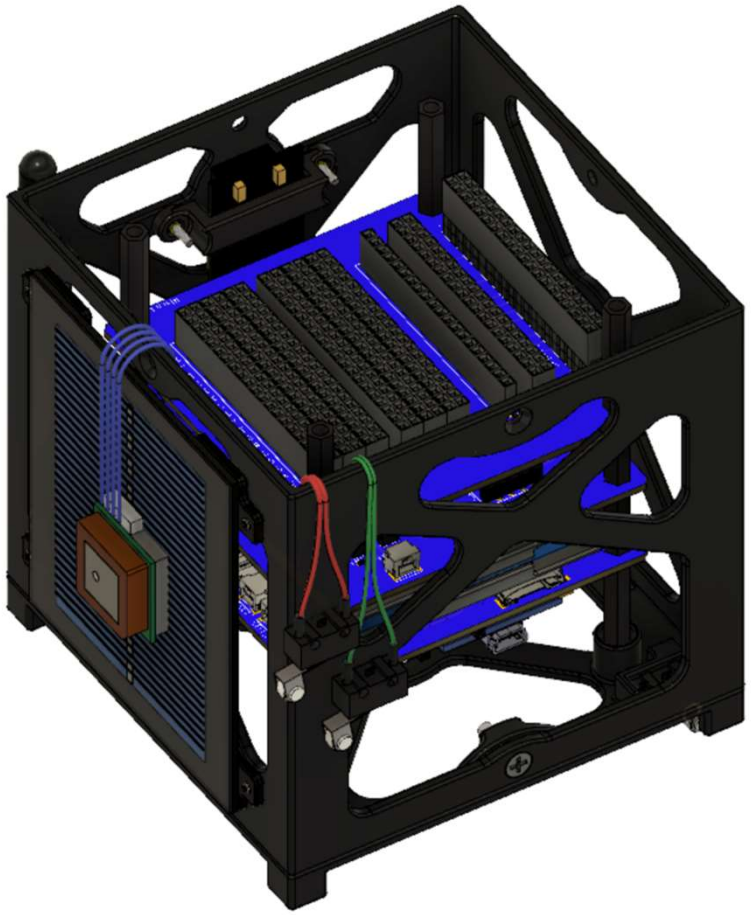
In this lecture, you will learn what a System is, what Systems Engineering is, what MBSE/SysML is, how to use hardware and software in CubeSat development, and how to design your own mission.

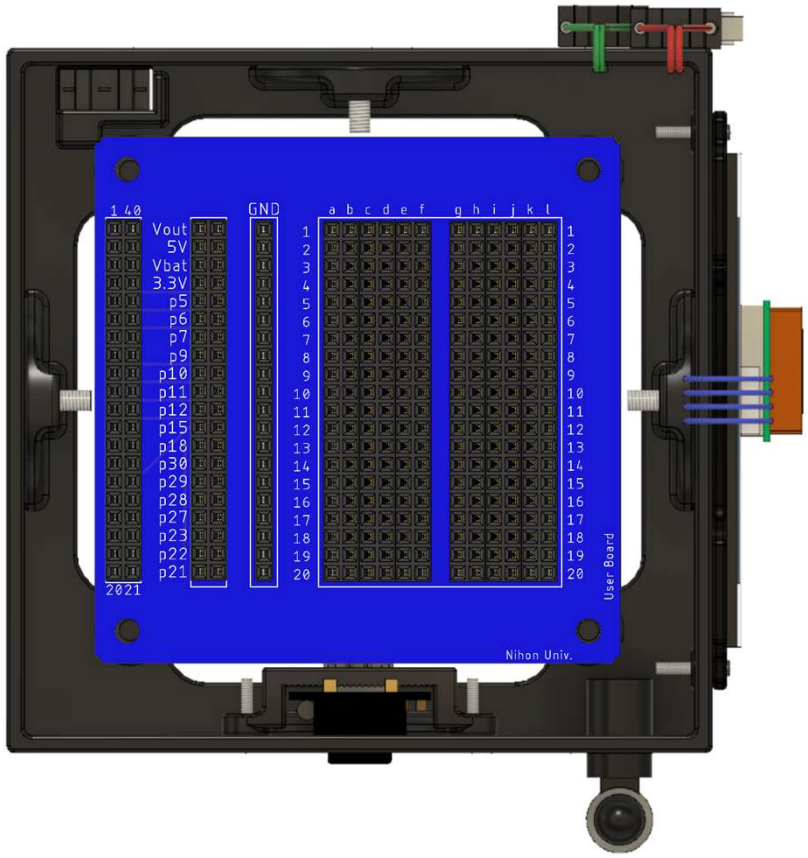
2. Designing our own mission

- In actual system development, it is necessary to design and develop a system under various constraints in order to realize something.
- To experience a part of design constraints and requirements, we must extend the HEPTA-Sat system by implementing new subsystems and functions using the HEPTA-Sat User board and some additional components.

2.1 How to Use User Board

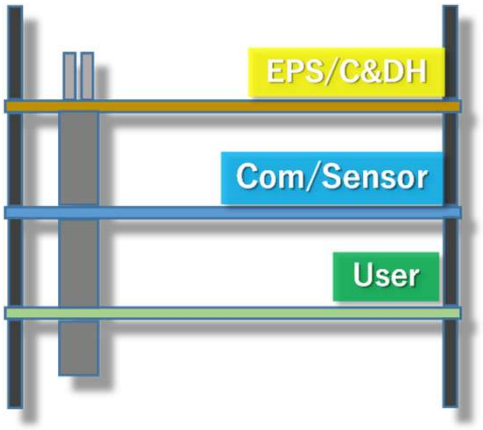
- HEPTA-Sat is equipped with a breadboard-like board called the User board. Sensors and other components can be freely attached to the board.

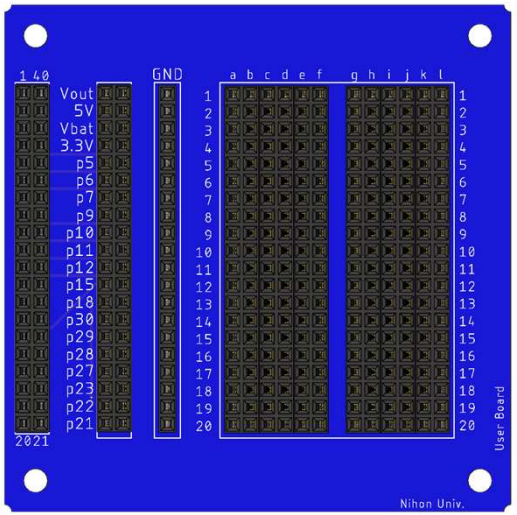




2.1 How to Use User Board

- The User board is connected to the other boards of HEPTA-Sat (EPS & C&DH board, Sensor & COM board) with 40 pins.

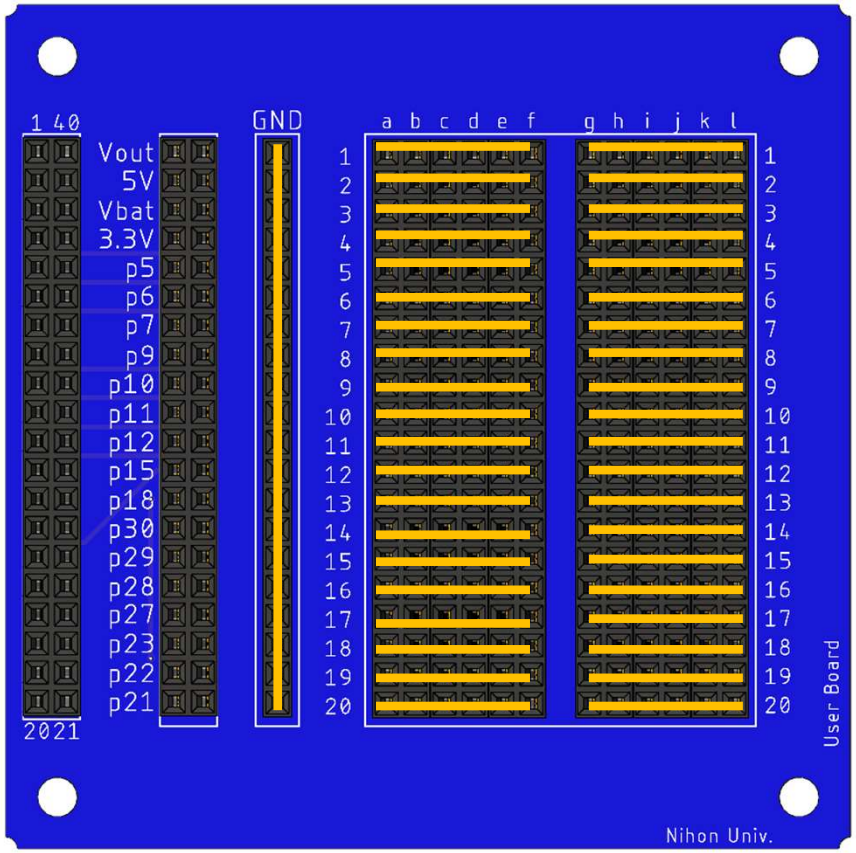


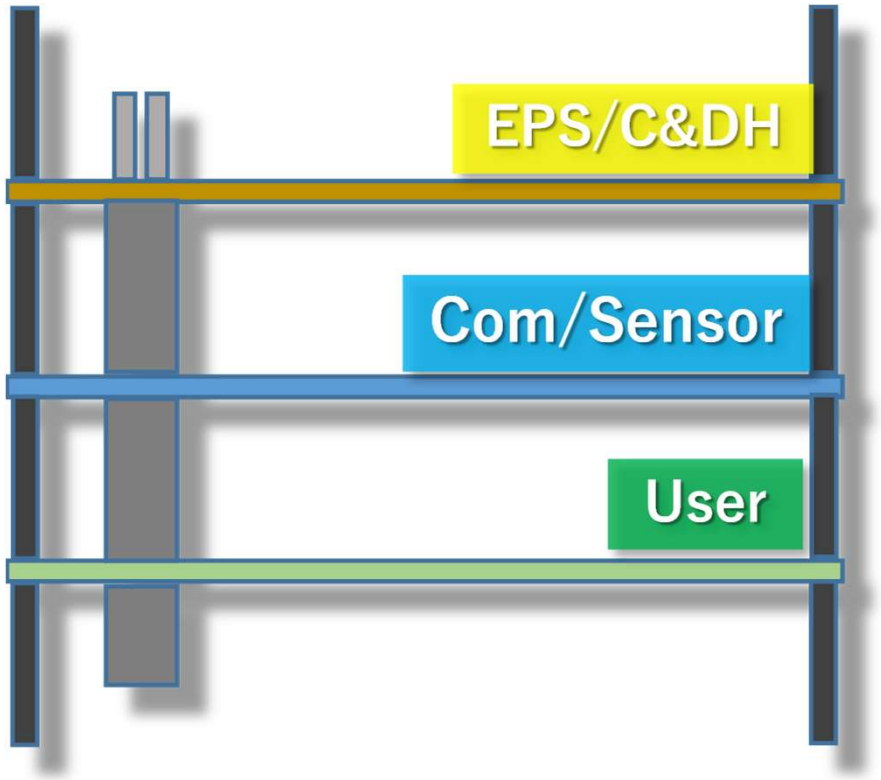


OBC Electrical Interface Table									
Pin No.	Interface Type		Component-1		Pin No.	Interface Type		Component-1	
1	GND	0V	–	–	40	Vout	3.3V	VDD	XBee
								VDD	SD Card
2	VIN	5V	Vout	5V Converter	39	Vu	5V		5V Converter
3	VB	–	–	–	38	–	5V	–	5V Converter
4	nR	–	–	–	37	–	5V	–	5V Converter
5	mosi	SPI	CMD	SD Card/user	36	–	~4.2V	–	Vbat
6	miso		DAT0		35	–	~4.2V	–	Vbat
7	sck		CLK		34	–	~4.2V	–	Vbat
8	Digital I/O	O	DAT3	SD Card	33	–	3.3V	–	3.3V Converter
9	tx	UART-1	Din	Xbee/user	32	–	3.3V	–	3.3V Converter
10	rx		Dout		31	–	3.3V	–	3.3V Converter
11	mosi	–	–	user	30	Digital I/O	I/O	–	–
12	miso	–	–	user	29	Digital I/O	I/O	–	–
13	tx	Serial	RxD	CAM	28	sda	I2C	sda	9-axis
								sda	user
14	rx	Serial	1O/I	Analog Switch	27	scl		scl	9-axis
			2O/I	Analog Switch				scl	user
15	Analog In	I	–	user	26	Digital I/O	O	EN	3.3V Converter
16	Analog In	I	V+	Battery	25	Digital I/O	I	2C	Analog Switch
17	Analog In	I	OUTD	OP Amplifer	24	Digital I/O	I	1C	Analog Switch
18	Analog I/O	I/O	I/O	user	23	Digital I/O	I	–	user
19	Analog In	I	I		22	Digital I/O	I	pwm	user
20	Analog In	I			21	Digital I/O	I	pwm	user

2.1 How to Use User Board

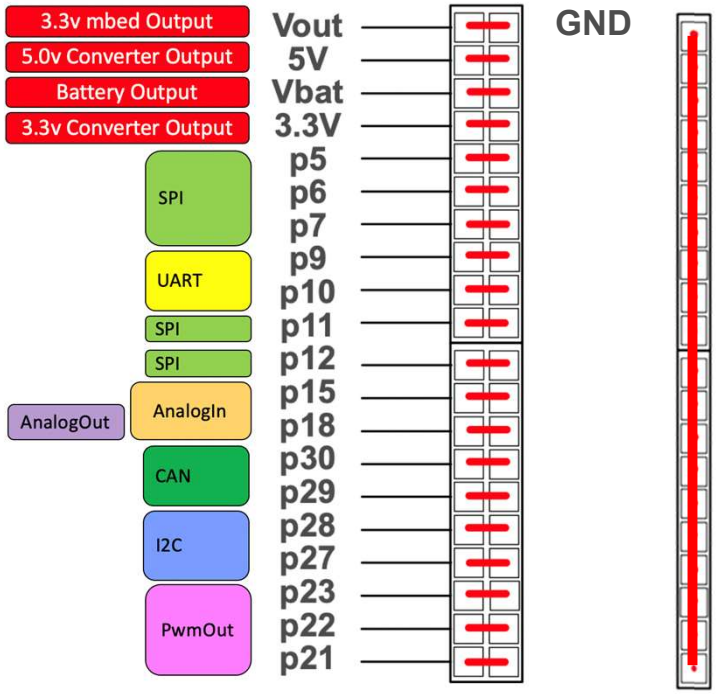
- The yellow lines in the figure below are common lines(electrically connected) for each(just like a breadboard).

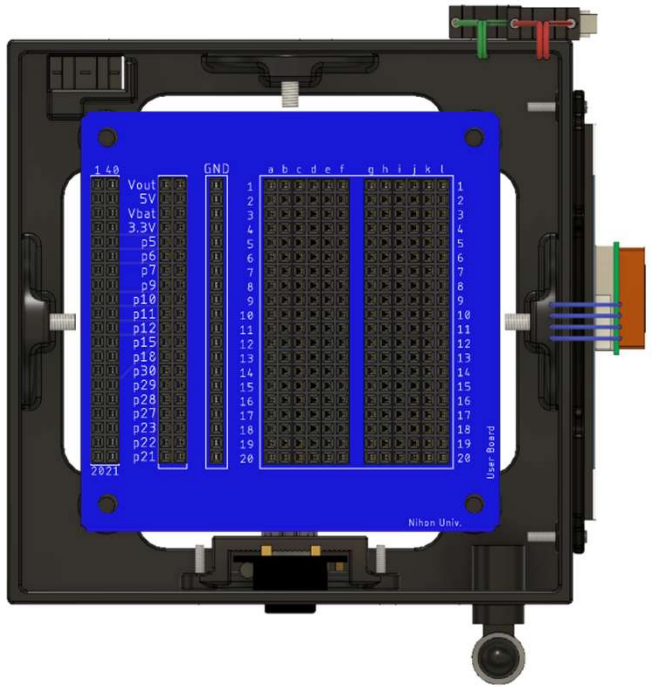




2.1 How to Use User Board

- The following interfaces are available on the User board.



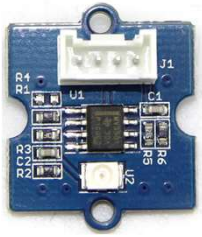


Interface and Constraints

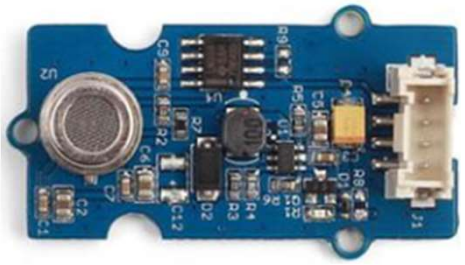
- **Power supply interfaces :**
  3.3V or 5V (The power supply source is common to other parts of HEPTA-Sat.)
- **Communication Interfaces :**
  SPI: p5,p6,p7,p11,p12, **UART:** p9,p10 (When you use this port, you cannot use xbee.)
  CAN:p29,p30, **I2C**: p27, p28, **Analog In**: p15, p18, **PWM**: p21, p22, p23.

2.1 How to Use Sensors

- Learn how to use Hardware with various mission components.
- Examples of mission components
  - Air Quality Sensors
  - Light Sensors
  - Atmospheric Pressure Sensors
  - Temperature and Humidity Sensors
  - Ultrasonic Distance Sensors ?
  - Ultraviolet Sensors
  - Resistors
  - Jumper Wires
  - Breadboard



Ultraviolet Sensor

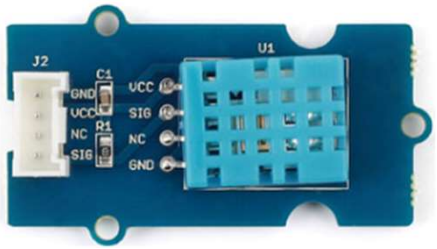


Air Quality Sensor

Ultrasonic Distance Sensor

Light Sensor

Atmospheric Pressure Sensor



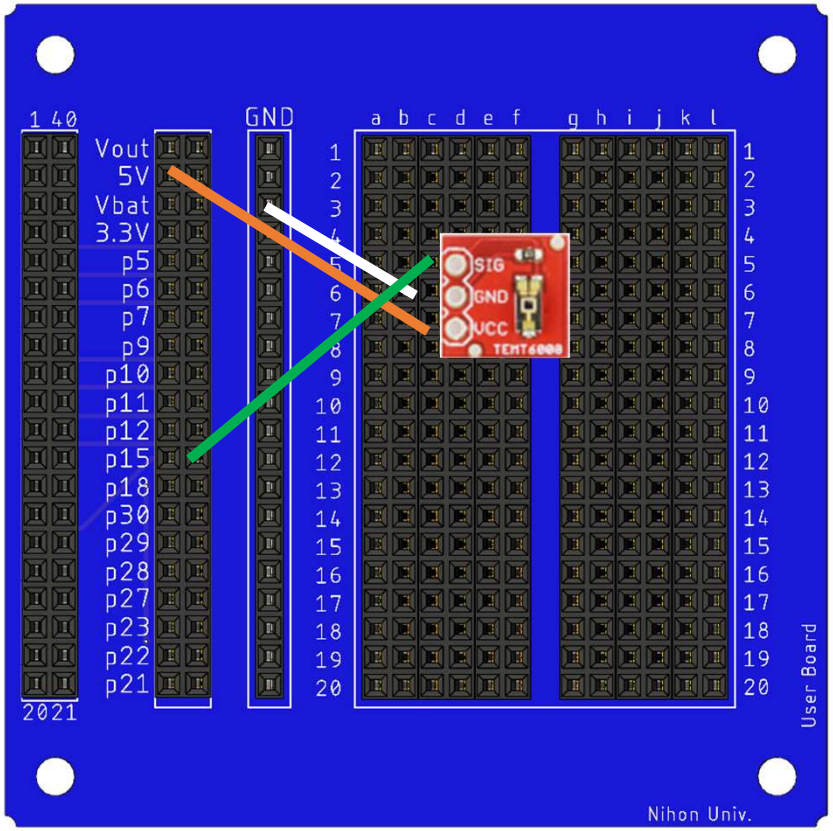
Temperature and Humidity Sensor

2.1 How to Use Sensors

- How to Use Light Sensors
  - The function of each pin
    - SIG:Analog line ⇔mbed_p15
    - GND:GND(0V) ⇔GND_line
    - VCC: 3.3~5V⇔mbed_5V or 3.3V
  - Features of Light Sensor
    - Range of Spectral Bandwidth (360–970 nm)
    - this sensor measures illuminance
    - Illuminance is expressed as the amount of luminous flux incident on a unit area. The unit is lx.
  - Let‘s download the following program from the “heptasat_program library”

Lab7-sample_light-sensor

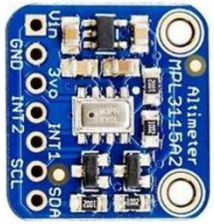
Light Sensor



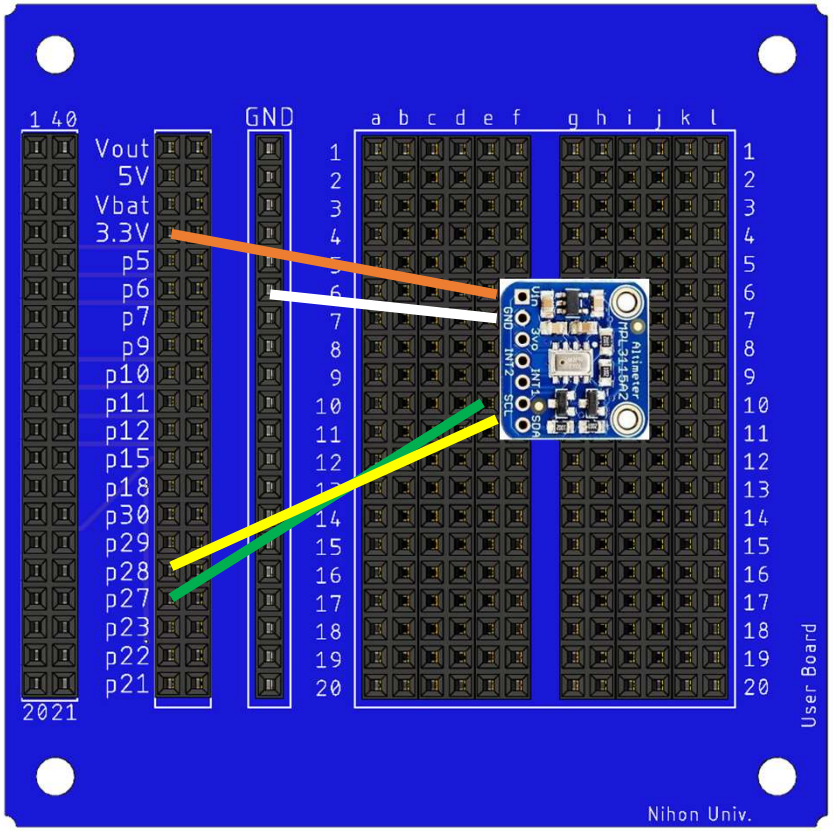
Circuit Example

2.1 How to Use Sensors

- How to Use Atmospheric Pressure Sensors
  - The function of each pin
    - SDA:I2C data line⇔mbed_p28
    - SCL:I2C clk line⇔mbed_p27
    - GND:GND(0V) ⇔GND_line
    - VIN: 3.0V~5V⇔mbed_3.3V or 5V
  - Features of Atmospheric Pressure Sensor
    - Atmospheric pressure :50kPa ～ 110kPa, Resolution: 20bit
    - Temperatures:-40℃ ～ ＋ 85, Resolution:12bit
    - Altitude : Resolution 20bit
  - Let's download the following program from the "heptasat_program library"
    - Lab7-sample_pressure-sensor



Atmospheric Pressure Sensor

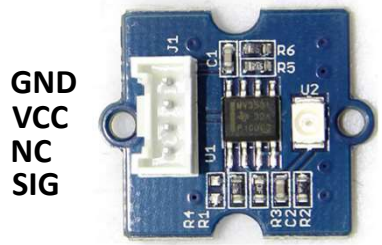


Circuit Example

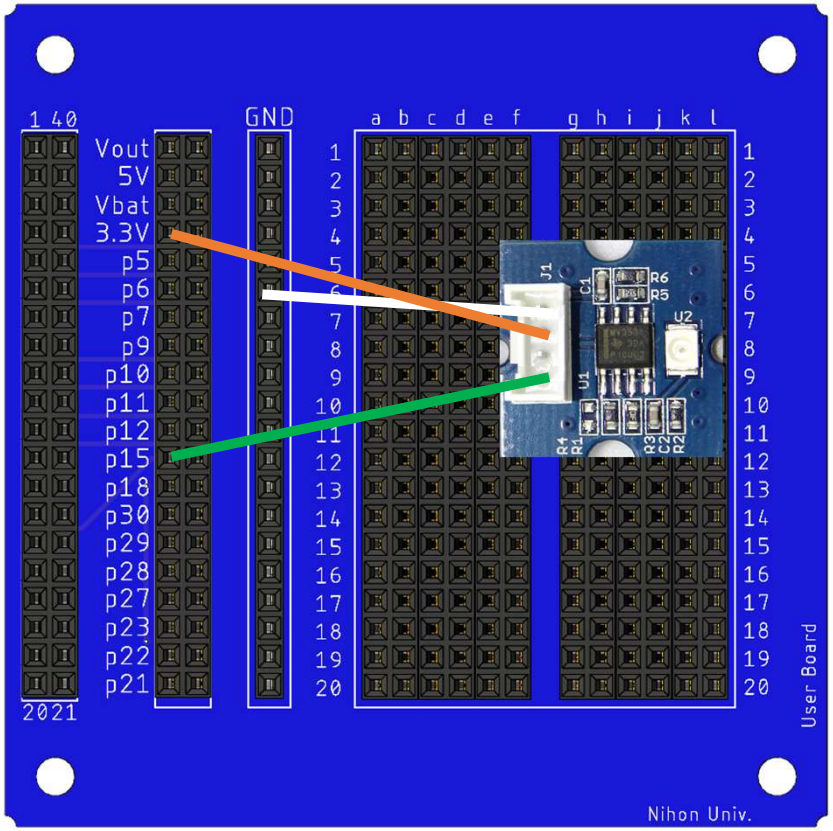
2.1 How to Use Sensors

- How to Use Ultraviolet Sensor
  - The function of each pin
    - SIG:Analog line⇔mbed_p15
    - GND:GND(0V) ⇔GND_line
    - VCC: 3.3 or 5V⇔mbed_3.3V or 5V
    - NC: Not connect
  - Features of Ultraviolet Sensor
    - Spectral sensitivity range : 320～410 nm
    - Peak Sensitivity : 355 nm
    - UVA Sensitivity : 5 μW/ cm2
  - Let's download the following program from the "heptasat_program library"

    Lab7-sample_uv-sensor



Ultraviolet Sensor

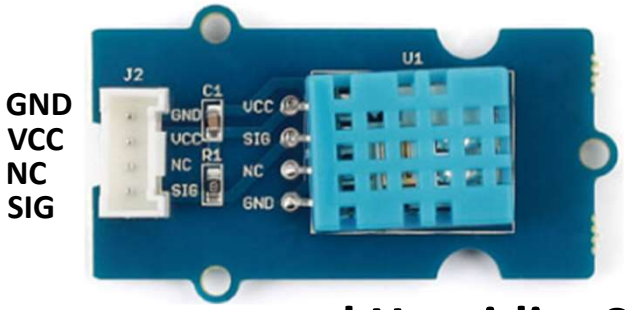


Circuit Example

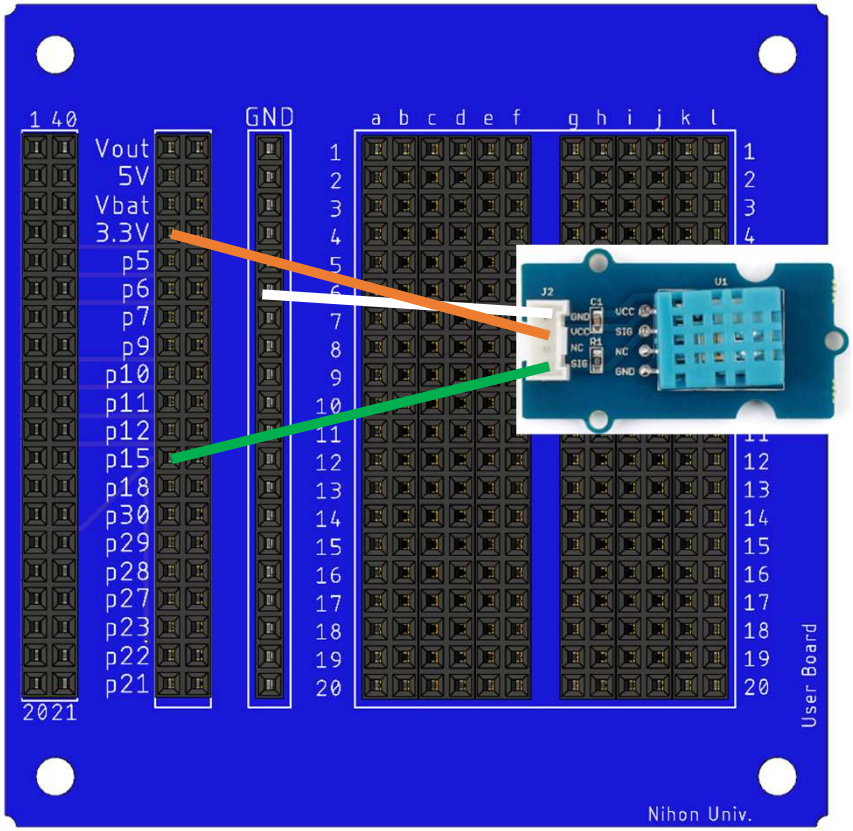
2.1 How to Use Sensors

- How to Use Temperature and Humidity Sensor
  - The function of each pin
    - SIG:Analog line⇔mbed_p15
    - GND:GND(0V) ⇔GND_line
    - VCC: 3.3 or 5V⇔mbed_3.3V or 5V
    - NC: Not connect
  - Features of Ultraviolet Sensor
    - Humidity range : 20~90%
    - Temperature range : 0~50℃
    - Humidity Accuracy : ±5%
    - Temperature Accuracy : ±2%
  - Let's download the following program from the "heptasat_program library"

    Lab7-sample_temp-humid-sensor



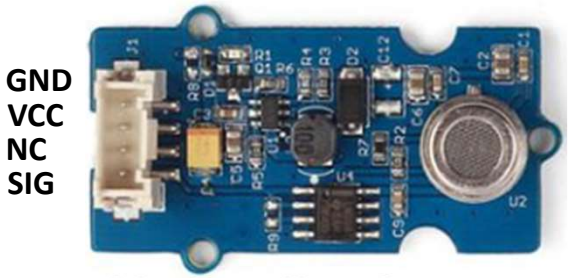
Temperature and Humidity Sensor



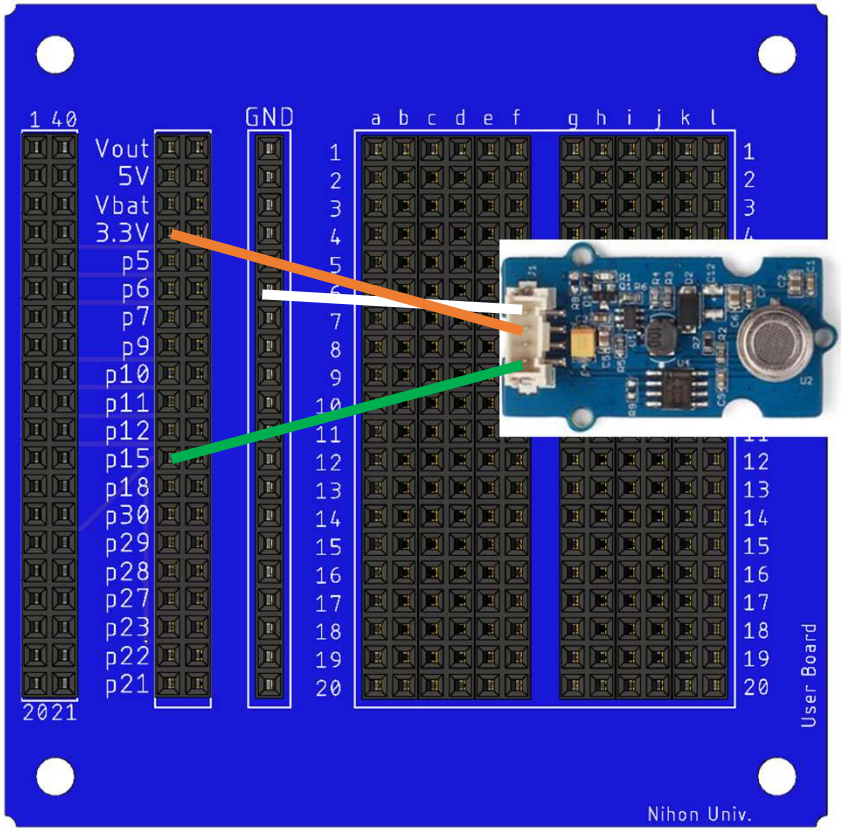
Circuit Example

2.1 How to Use Sensors

- How to Use Air Quality Sensor
  - The function of each pin
    - SIG:Analog line⇔mbed_p15
    - GND:GND(0V) ⇔GND_line
    - VCC: 3.3 or 5V⇔mbed_3.3V or 5V
    - NC: Not connect
  - Features of Ultraviolet Sensor
    - The main gases detected are carbon monoxide, alcohol, acetone, thinner, formaldehyde and other slightly toxic gases.
    - Air quality is represented by four statuses.
  - Let's download the following program from the "heptasat_program library"
    - Lab7-sample_air-quality-sensor



Air Quality Sensor



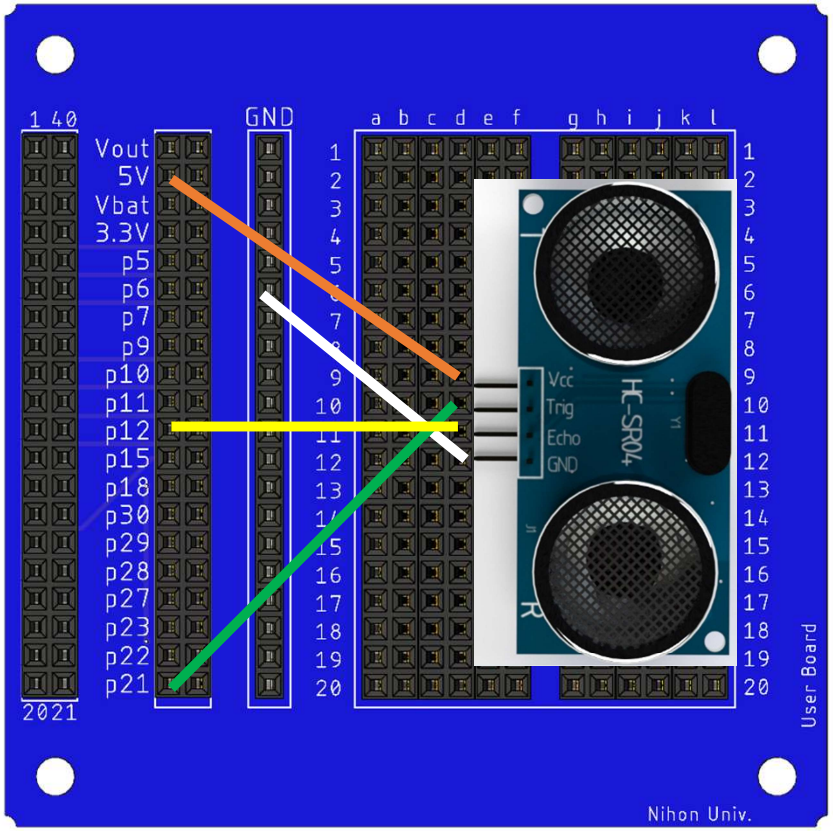
Circuit Example

2.1 How to Use Sensors

- How to Use Ultrasonic Distance Sensor
  - The function of each pin
    - Trig: Signal output ⇔mbed_p21
    - Echo: Signal input ⇔mbed_p12
    - GND:GND(0V) ⇔GND_line
    - VCC: 5V⇔mbed_ 5V
  - Features of Ultraviolet Sensor
    - Determine the possible distance 2cm～450cm
    - Distance resolution : 0.3cm
    - Sensor angle : 15° max
  - Let's download the following program from the "heptasat_program library"

    Lab7-sample_ultrasonic-sensor

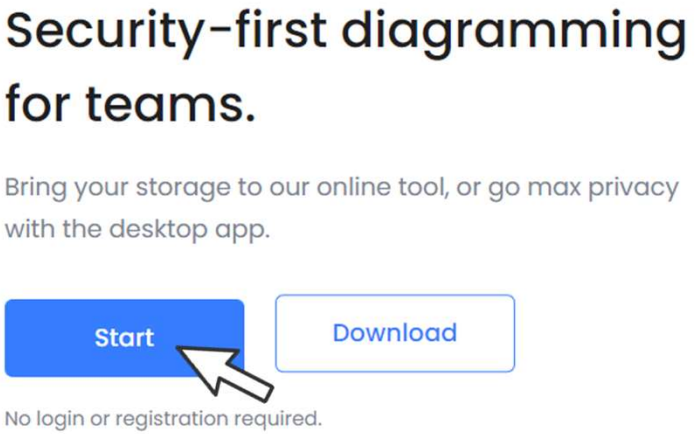
Ultrasonic Distance Sensor

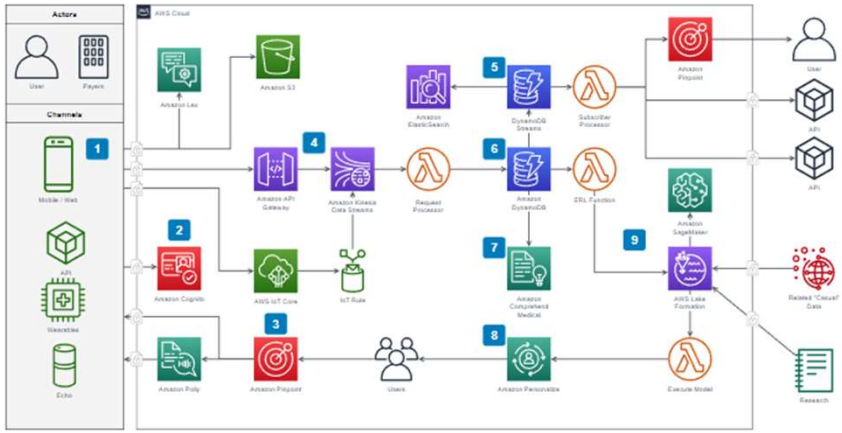


Circuit Example

2.2 How to Use Software (diagrams.net)

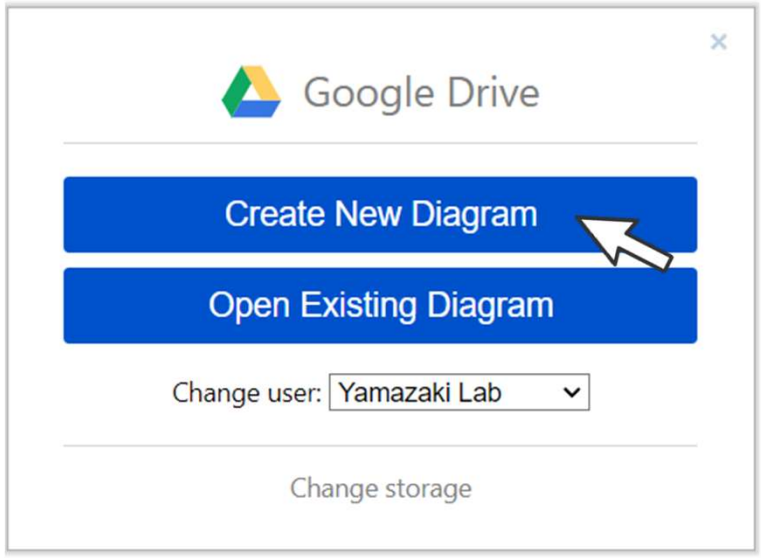
- You will use diagrams.net as a tool to represent the system in a model.
- diagrams.net is an open source, online, desktop software used to draw diagrams(https://www.diagrams.net/).
- Try entering the site from the link above and clicking on "Start" .

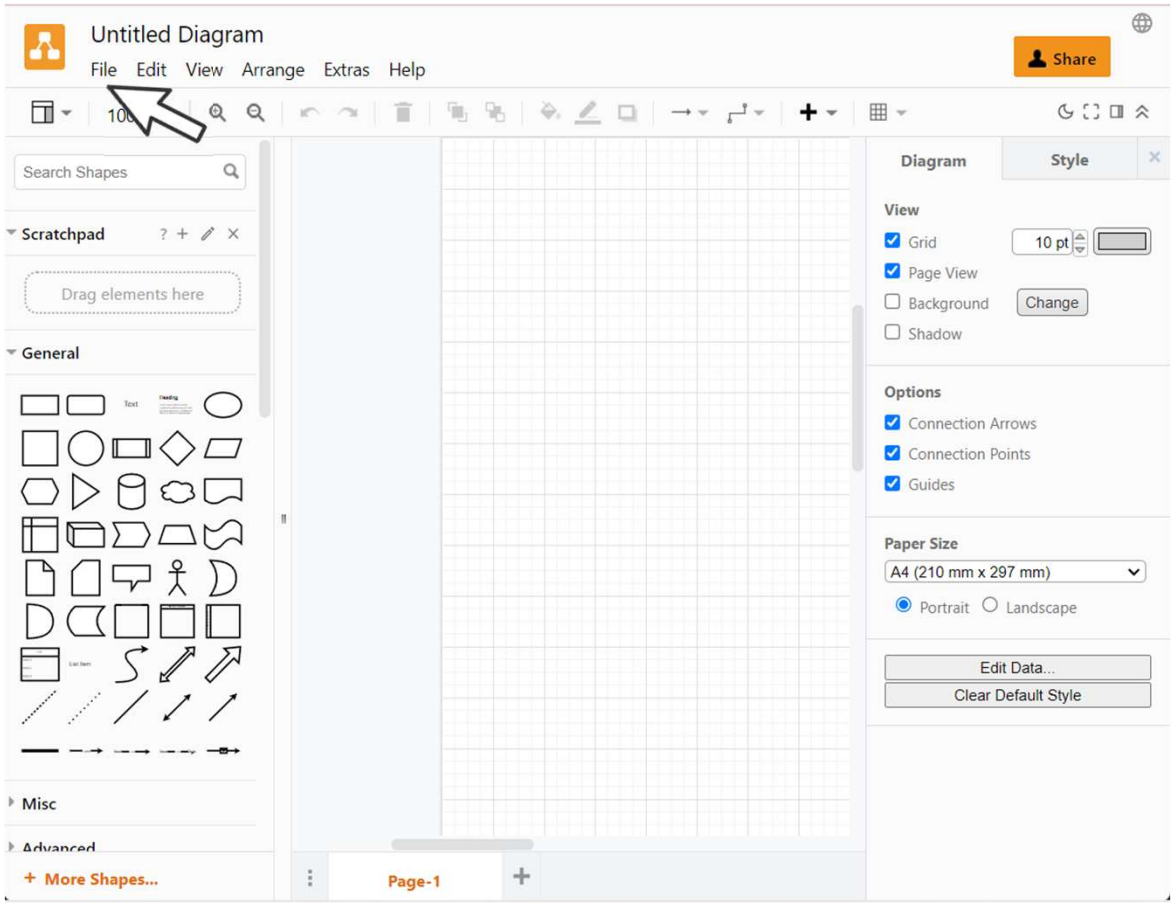




2.2 How to Use Software (diagrams.net)

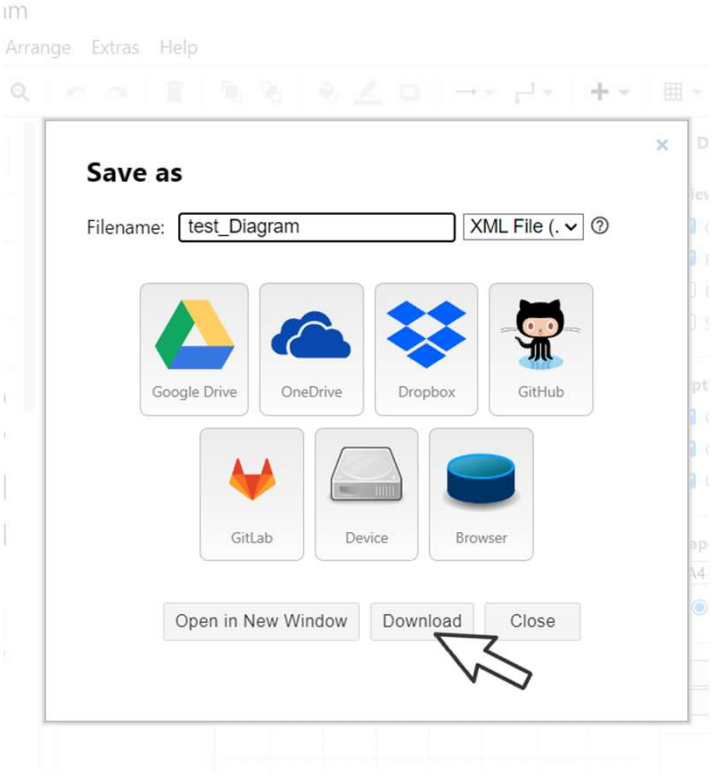
- Click on "Create New Diagram" (you need to create a Google account first).
- Click on "File", then click on "Save".

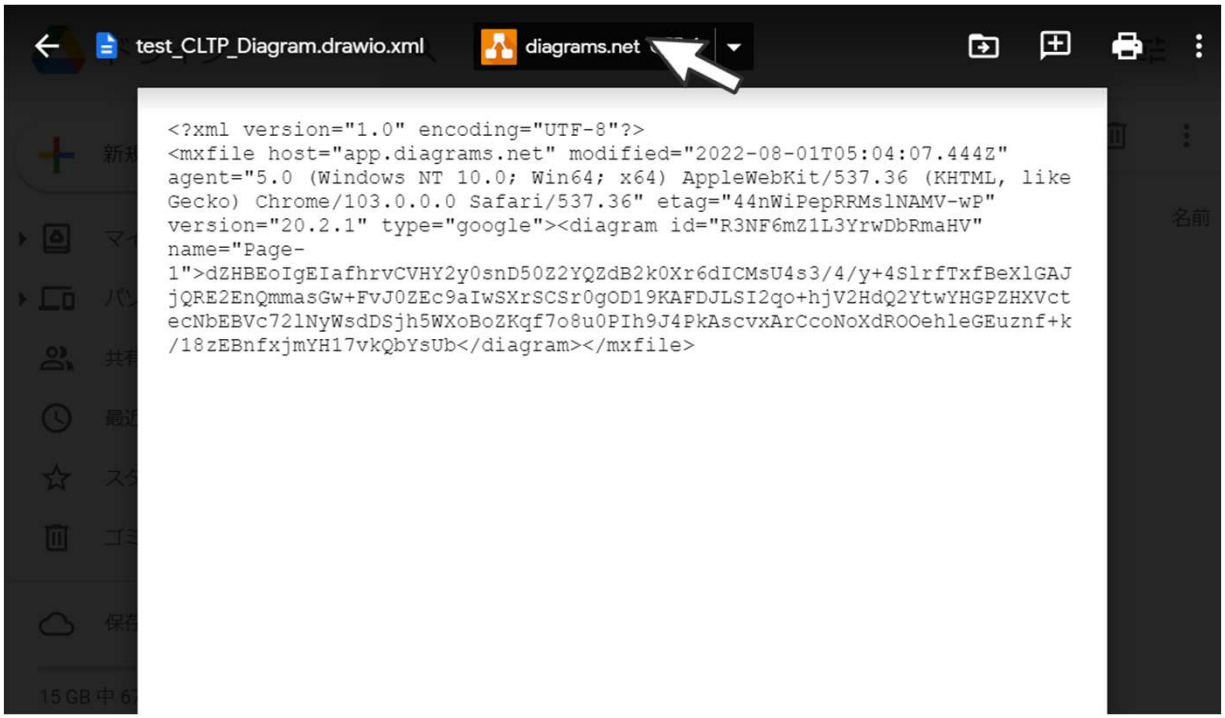




2.2 How to Use Software (diagrams.net)

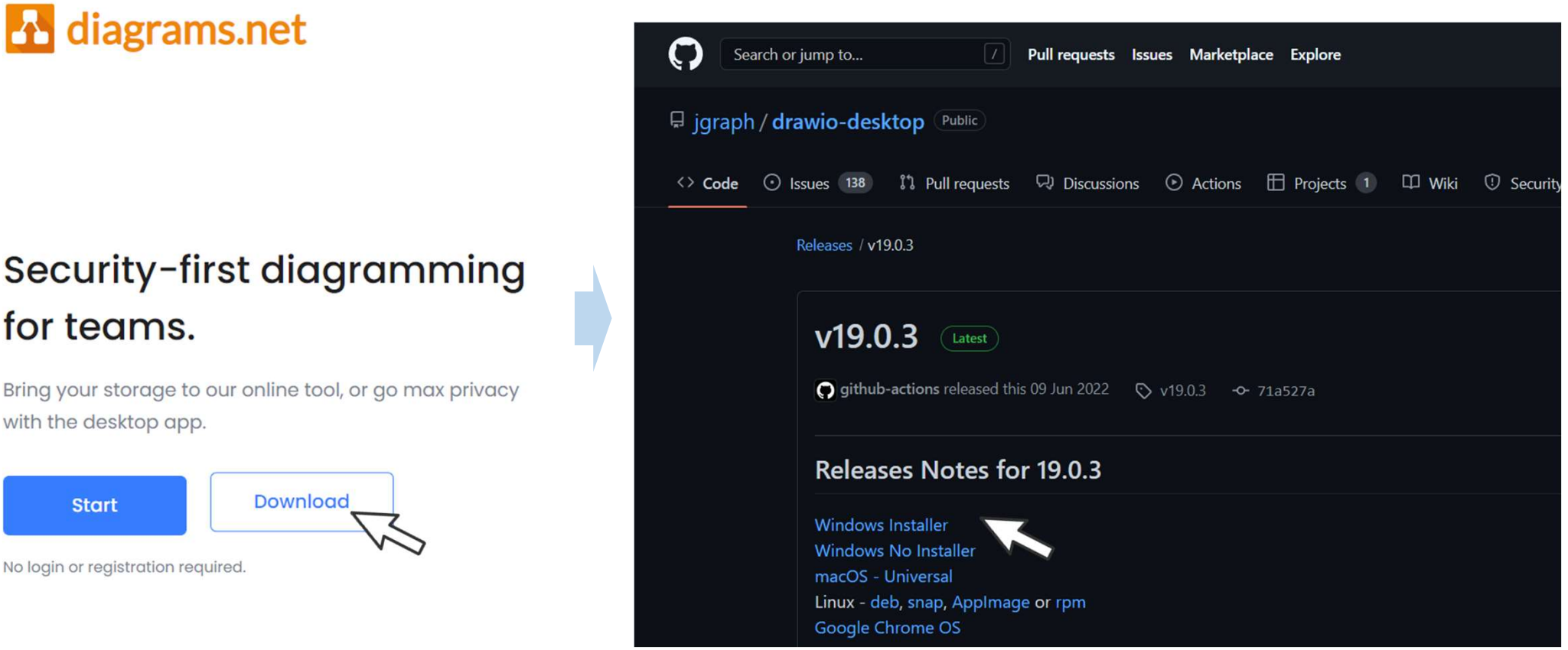
- Name the file "test_Diagram" then download it in XML file format..
- Upload the downloaded file to the link
- Finally, check if the uploaded file can be opened.





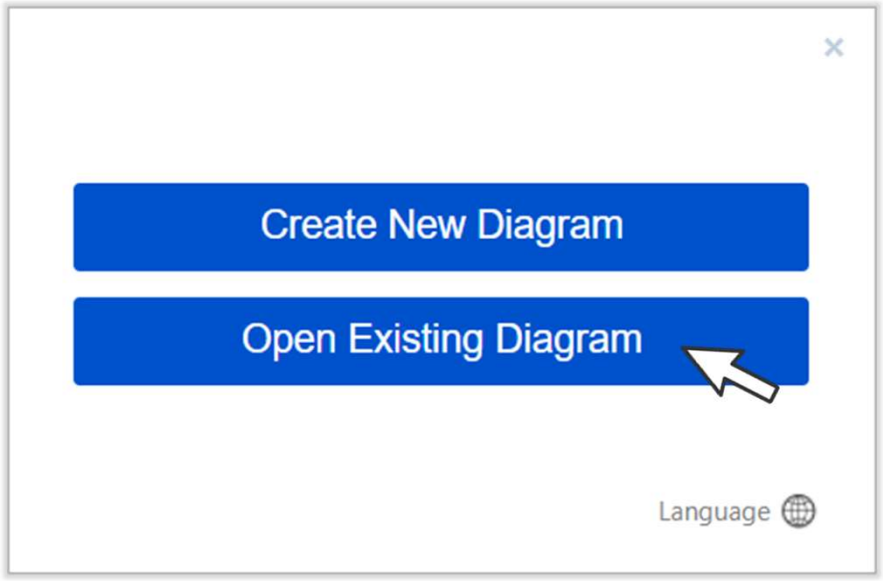
2.2 How to Use Software (diagrams.net)

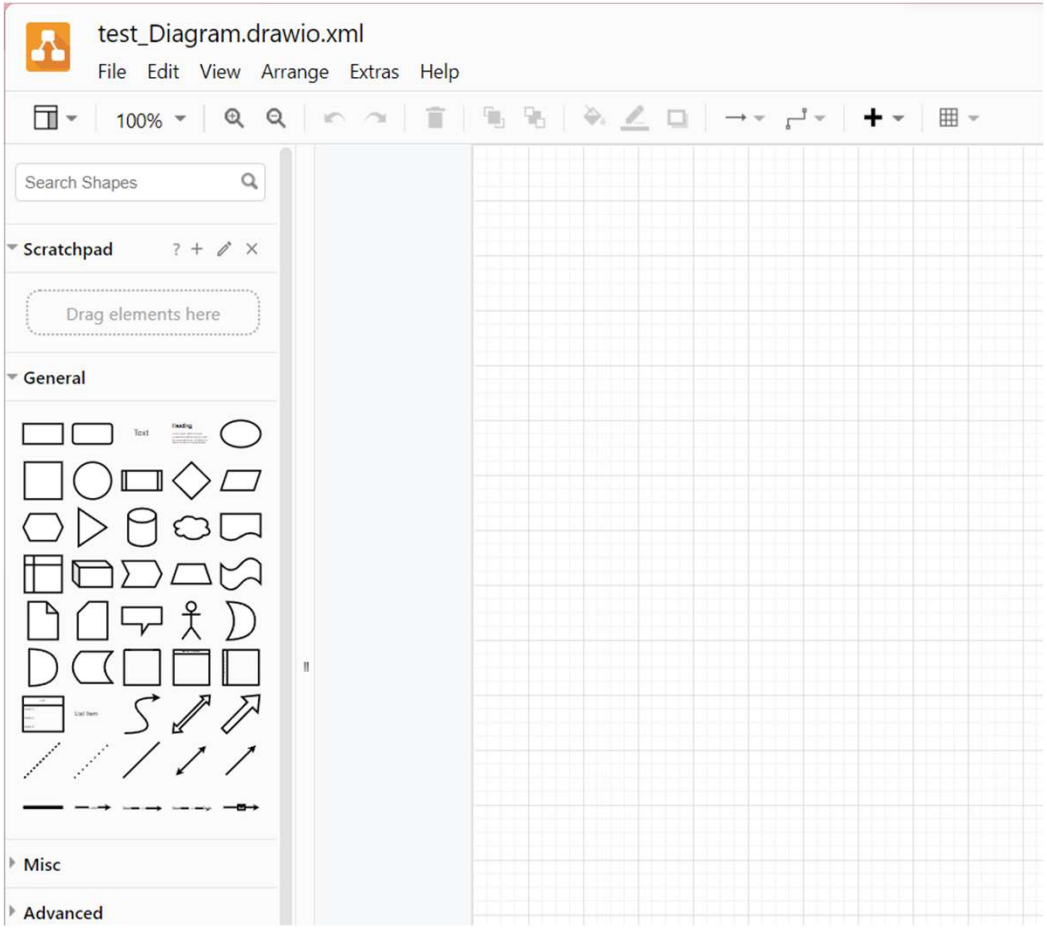
- Try entering the site from the link(https://www.diagrams.net/) again.
- Then click on "Download".
- Download the appropriate installer for your computer from the GitHub page.
- Finally, check if the drawio-desktop application can be opened.



2.2 How to Use Software (diagrams.net)

- Click on "Open Existing Diagram".
- Open the XML file of test_Diagram.
- Once you have completed this step, the installation of diagrams.net is complete.





2.3 HEPTA-Sat Sample Mission Example

- Copy the XML file “HEPTA-Sat_Sample_Model” from the USB port of HEPTA-Sat to your PC or copy the file from the link.
- In this chapter, we show an example of mission design using the file "HEPTA-Sat_Sample_Model".