Biodiversity Greece

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PROJECT	LIFE18 GIE/GR/000899
PROJECT TITLE	Hellenic Biodiversity Information System: An innovative tool for biodiversity conservation.
ACRONYM	LIFE EL-BIOS
ACTION	B4
DELIVERABLE NUMBER	B4.1
DELIVERABLE TITLE	Replication Guide 1 [UTH-DECE]: System design for the collection, processing and communication of the environmental data collected through wireless sensor nodes in Natura 2000 protected areas.
REPORT STATUS	Complete
COMPLETION DATE	31/12/2024
RESPONSIBLE	University of Thessaly

LIFE EL-BIOS (LIFE20 GIE/GR/001317) has received funding from the LIFE Programme of the European Union.
EU funding contribution: 1.354.524 € (52.68% of total eligible budget).

LIFE EL-BIOS has received funding from GREEN FUND

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DOCUMENT TITLE:

System design for the collection, processing and communication of the environmental data collected through wireless sensor nodes in Natura 2000 protected areas.

SUGGESTED CITATION:

- Raspberry Pi documentation
- Waveshare Power Management HAT documentation
- Computer Networking, A Top-Down Analysis (Kurose|Rose)
- Python Data Analytics, Data Analysis and Science Using Pandas, matplotlib, and the Python Programming Language (Fabio Nelli)

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ACRONYMS & ABBREVIATIONS LIST

ENGLISH	
WSN	Wireless Sensor Network
3G	3rd Generation
IoT	Internet of Things
4G	4th Generation
5G	5th Generation
AI	Artificial Intelligence
CNN	Convolutional Neural Networks
D**B**	Database
DC	Direct Current
GWN	Gateway Node

EXECUTIVE SUMMARY

Building a sensor node can be an enriching experience, blending the intricacies of hardware with the logic of software. This guide will provide you with detailed steps to construct a basic EL-BIOS sensor node, explaining the required components and the process involved.

1. Materials and Tools Needed

- Solar Panel (10 Watts)
- Maxlink Alubox aluminum waterproof universal mounting box (metal case)
- Waveshare Solar Power Manager (C)
- DC-DC Adjustable Boost Buck Converter 3.8V - 32V
- Waveshare Power Management HAT for Raspberry Pi
- Raspberry Pi 4 (or 5)
- Adafruit BME280 I2C or SPI Temperature Humidity Pressure Sensor
- Rode VideoMicro Microphone
- 3x Batteries, 3.7V - 1500 mAh
- UGREEN Sound card USB 2
- 4G USB Dongle (if using LTE to send data to database)
- Connecting Wires: Jumper wires
- Software: Arduino IDE
- Computer: To upload code to the microcontroller

2. EL-BIOS sensor node overview

EL-BIOS custom sensor node operates autonomously by harvesting solar energy. Initially, energy is harvested from a solar panel. The solar panel is then connected to a Waveshare Solar Power Manager (C), which optimizes the charging and discharging of connected batteries (3x Batteries, 3.7V - 1500 mAh), to ensure efficient energy utilization. Following this, the Waveshare Solar Power Manager (C) connects to a DC-DC Adjustable Boost Buck Converter (3.8V - 32V), stepping up the voltage from 5V to 10V, a crucial process for providing the necessary voltage. The step-up converter is then connected to a Waveshare Power Management HAT for Raspberry Pi.

This HAT regulates the incoming 10V voltage to provide a stable and suitable power supply. Critically, it also controls the intervals that the Raspberry Pi is turned on, further conserving energy. Next, the Waveshare Power Management HAT for Raspberry Pi provides power to Raspberry Pi during its designated intervals, enabling its operation. With power supplied, sensors connected to the Raspberry Pi allow for the collection of environmental and sound data. Finally, the collected data are sent using LTE (Long-Term Evolution, a 4G wireless broadband technology), enabling remote data transmission.

3. Setting Up the Waveshare Power Management HAT for Raspberry Pi

Start by setting up the Waveshare Power Management HAT for Raspberry Pi.

Download and install the Arduino IDE from the official Arduino website.

Connect your Waveshare Power Management HAT for Raspberry Pi to your computer using a USB cable.

Open the Arduino IDE and select the appropriate board and port from the Tools menu.

Upload code.

Important notice: Proprietary Code – Formal Request Required. The source code needed is proprietary to [Nitlab/University of Thessaly]. A formal written request to [christefthymiou@uth.gr] is required to obtain access to the code.

4. Building the EL-BIOS sensor node

Next, connect all the bits and pieces as shown in the picture of Appendix 2.
Important: Soldering is necessary to connect the Waveshare Solar Power Manager (C) to the DC-DC Adjustable Boost Buck Converter, and the DC-DC converter to the Waveshare Power Management HAT.
Please refer to Appendix 3 on how to connect Adafruit BME280 I2C or SPI Temperature Humidity Pressure Sensor to Raspberry Pi.

5. Writing the Code

With the sensors connected, it is time to write the code to read data from the sensors and send it to the microcontroller.
Important notice: Proprietary Code – Formal Request Required The source code needed is proprietary to [Nitlab/University of Thessaly]. A formal written request to [christefthymiou@uth.gr] is required to obtain access to the code.

6. Uploading the Code to Raspberry Pi

Once you have written the code, it is time to upload it to the microcontroller.

Steps to Write a Custom Image to an SD Card using Raspberry Pi Imager. Download and Install Raspberry Pi Imager (if you have not already):

Go to the official Raspberry Pi website: https://www.raspberrypi.com/software/

Download the appropriate version for your operating system (Windows, macOS, or Linux).

Install the software following the on-screen instructions.

Insert SD Card into Your Computer:

Launch Raspberry Pi Imager:

Open the Raspberry Pi Imager application.

Choose "Use Custom" Image:

Click on the "Choose OS" button (or the operating system selection dropdown).

Scroll to the bottom of the list.

Select "Use custom" (or a similar option, depending on the Imager version). This allows you to browse for a local image file.

Select Your Custom Image File:

A file browser window will appear.

Navigate to the location where you saved your custom .img or .img.gz file.

Select the file and click "Open".

Select Your SD Card:

Click on the "Choose Storage" button.

Select the correct SD card from the list. Be very careful to choose the right drive, as the process will erase all data on the selected drive.

Write the Image:

Click the "Write" button.

You may be prompted to confirm your selection. Double-check everything before proceeding.

The Raspberry Pi Imager will now write the custom image to the SD card. This process may take several minutes, depending on the size of the image and the speed of your SD card reader.

Verification:

After writing the image, Raspberry Pi Imager will typically verify the writing. Let it finish. Once complete, you will see a message indicating that the writing was successful.

Eject the SD Card

Boot Your Raspberry Pi. Your Raspberry Pi should now boot using your custom image.

Important notice: Proprietary Code – Formal Request Required The custom image code needed is proprietary to [Nitlab/University of Thessaly]. A formal written request to [christefthymiou@uth.gr] is required to obtain access to the code.

7. Powering the Sensor Node

After uploading the code, you need to power your sensor node.

8. Reading Sensor Data

With the sensor node powered and the code running, you can now read data from the sensors.

9. Enclosure Adafruit BME280 I2C or SPI Temperature Humidity Pressure Sensor in protective case

To protect your sensor and take more accurate readings, you can build an enclosure. STL design files for 3D-printed enclosures are available upon request. Please contact [christefthymiou@uth.gr] to obtain the design files.

APPENDIX 1

Figure 1 - Solar Panel (10 Watts)

Figure 2 - Maxlink Alubox

Figure 3 - Waveshare Solar Power Manager (C)

Figure 4 - DC-DC Adjustable Boost Buck Converter 3.8V - 32V

Figure 5 - Waveshare Power Management HAT for Raspberry Pi

Figure 6 - Raspberry Pi 4 (or 5)

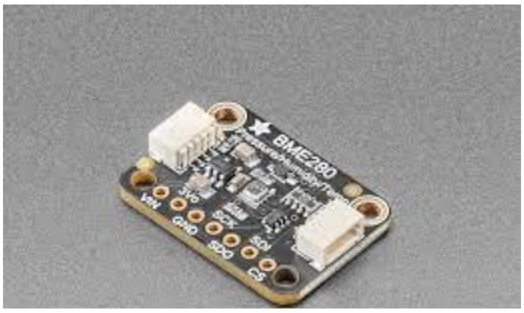


Figure 7 - Adafruit BME280 I2C or SPI Temperature Humidity Pressure Sensor

Figure 8 - Rode VideoMicro Microphone

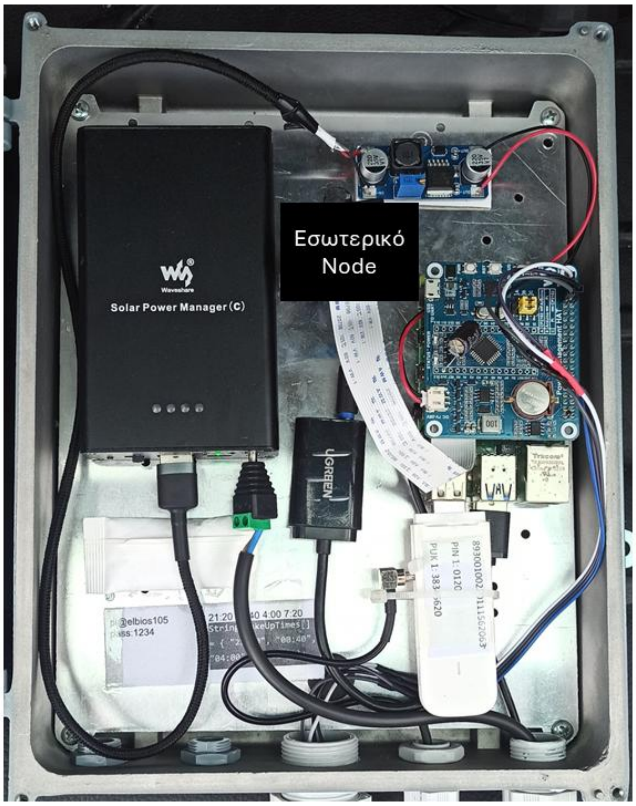
Figure 9 - Battery, 3.7V - 1500 mAh

Figure 10 - UGREEN Sound card USB 2

Figure 11 - 4G USB Dongle

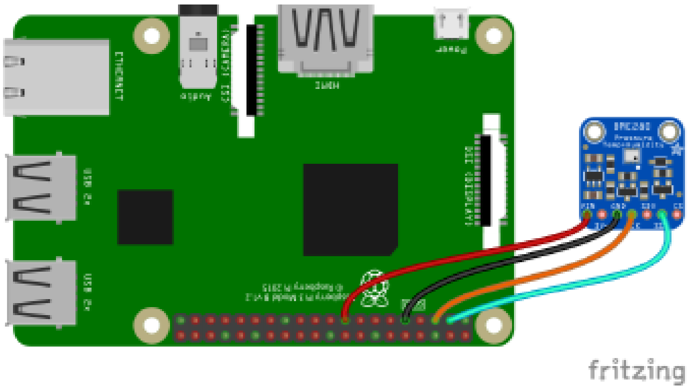
Figure 12 - Jumper wires

APPENDIX 2



APPENDIX 3

Wiring up the sensor



- Connect up the sensor to your Pi as shown in the diagram above.

Pi GPIO BME280

17 (3V3) Vin

6 (Gnd) Gnd

3 (SDA) SDA (SDI)

5 (SCL) SCL (SCK)