



UNIVERSITY OF THE
AEGEAN

SCHOOL OF ENGINEERING
DEPARTMENT OF PRODUCT AND
SYSTEMS DESIGN ENGINEERING

IOHIVE: Designing Interactive Systems for Sustainable Beekeeping



IOHIVE Team

FOSSCOMM - Lamia,
November 20, 2022

About us

- Department of Product & Systems Design Engineering
- Interactive Systems Design Lab / IOHIVE team



What we do

Design and Develop Interactive Digital Systems and Services for the Support and Horizontal Monitoring of Agri-Food Practices with focus on Sustainable Beekeeping

May 20, 2022




World Bee Day

Beekeeping is a widespread and global activity, with millions of beekeepers depending on bees for their livelihoods and well-being. Together with wild pollinators, bees play a major role in maintaining biodiversity, ensuring the survival and reproduction of many plants.

To raise awareness of the importance of pollinators, the threats they face and their contribution to sustainable development, the UN designated 20 May as World Bee Day.

We all depend on pollinators and it is, therefore, crucial to monitor their decline and halt the loss of biodiversity.

United Nations A/RES/72/211

 **General Assembly** Distr.: General
17 January 2018

Seventy-second session
Agenda item 19

**Resolution adopted by the General Assembly
on 20 December 2017**

[on the report of the Second Committee (A/72/420)]

72/211. World Bee Day

The General Assembly,

Reaffirming its resolution 70/1 of 25 September 2015, entitled “Transforming our world: the 2030 Agenda for Sustainable Development”, in which it adopted a comprehensive, far-reaching and people-centred set of universal and transformative Sustainable Development Goals and targets, its commitment to working tirelessly for the full implementation of this Agenda by 2030, its recognition that eradicating poverty in all its forms and dimensions, including extreme poverty, is the greatest global challenge and an indispensable requirement for sustainable development, its commitment to achieving sustainable development in its three dimensions — economic, social and environmental — in a balanced and integrated manner, and to building upon the achievements of the Millennium Development Goals and seeking to address their unfinished business,

Reaffirming also its resolutions 53/199 of 15 December 1998 and 61/185 of 20 December 2006 on the proclamation of international years, and Economic and Social Council resolution 1980/67 of 25 July 1980 on international years and anniversaries, particularly paragraphs 1 to 10 of the annex thereto on the agreed criteria for the proclamation of international years, as well as paragraphs 13 and 14, in which it is stated that an international day or year should not be proclaimed before the basic arrangements for its organization and financing have been made,

Recognizing the importance of promoting sustainable development in its three dimensions in an innovative, coordinated, environmentally sound, open and shared manner, and the urgent need to protect bees and other pollinators in a sustainable manner.

Source: <https://bit.ly/3PAJRiz>

Beekeeping and Cultural Heritage

- Beekeeping is not just a profession
- An activity with long history and traditional expressions
- The prevalence of skills, knowledge and good practice passed down from generation to generation
- Each place had its own unique identity
- List of the Intangible Cultural Heritage of Humanity



Beekeeping and Climate Change

- Bees are under threat. The bee population is constantly decreasing
- Human activities such as
 - changes in land use
 - intensive agricultural practices and the use of pesticides
 - pollution
- Pests / diseases (Colony Collapse Disorder, Varroa)
- It's not just about the honey
- Ensuring the world's food security



Beekeeping in the Cyclades: The challenge

- Special environmental conditions
- Large variety of aromatic plants
- High quality products (e.g. thyme honey)
- Small production but high value
- No nomadic beekeeping
- Times of drought
- Tourism is a threat

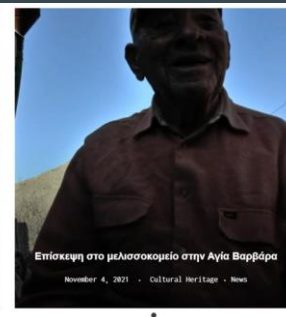
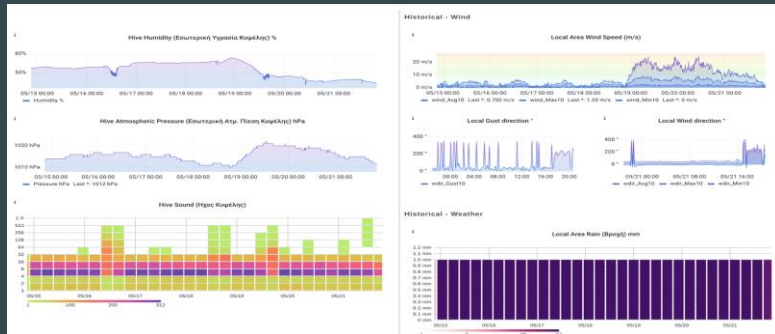




MYHIVE

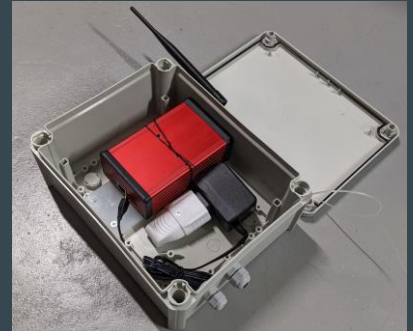
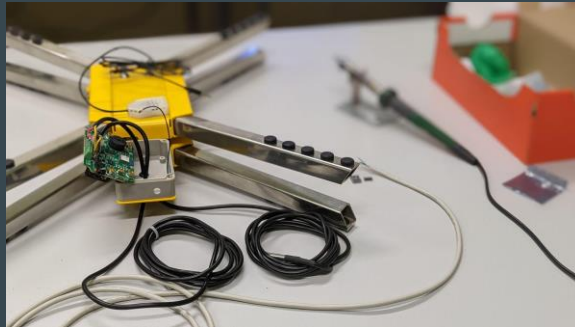
MyHive: Interactive platform for the adoption of bee hives

- A new approach to beekeeping and tourism
- Raising awareness
- Give value to local producers
- Roles
 - Beekeeper (monitor data / manage adoptions / schedule tours)
 - Adopter (learn / inspect / grab your honey)
 - Content creator (articles, interviews, blog)

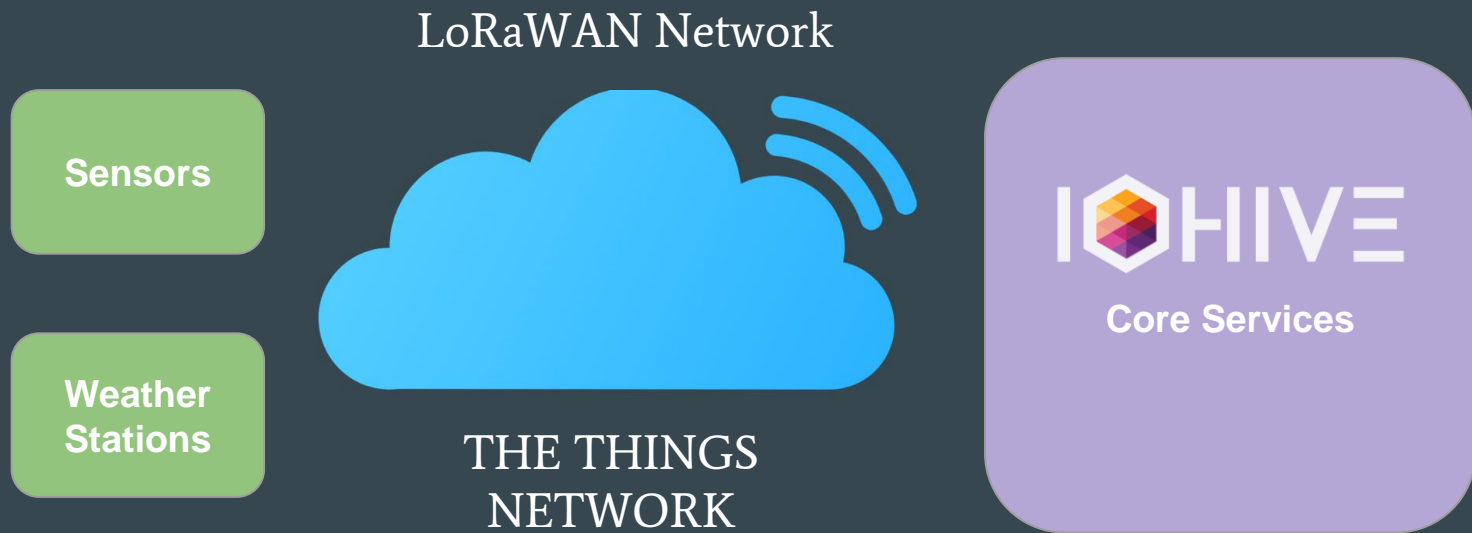


IOHIVE: Internet of Interactive Hives

- Hive monitoring with autonomous sensors based on IoT solutions
- Application of LoRaWAN technology in Precision Beekeeping
- Data visualization and analytics
- Interactive Systems for Journaling of Beekeeping Activities based on Tangible and Wearable Interface



The idea



IOHIVE: Partners



ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΙΓΑΙΟΥ

**Μηχανικών Σχεδίασης Προϊόντων και Συστημάτων
Εργαστήριο Σχεδίασης Διαδραστικών Συστημάτων**

www.syros.aegean.gr



ΕΛΓΟ ΔΗΜΗΤΡΑ

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Οικοσυστημάτων**

Εργαστήριο Μελισσοκομίας

www.fria.gr

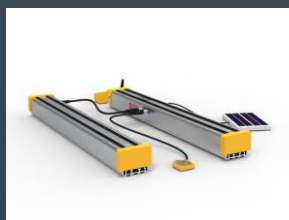
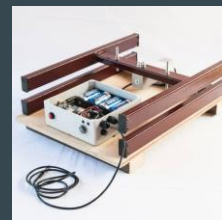
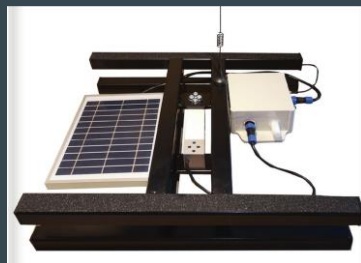


KUDZU I.K.E.

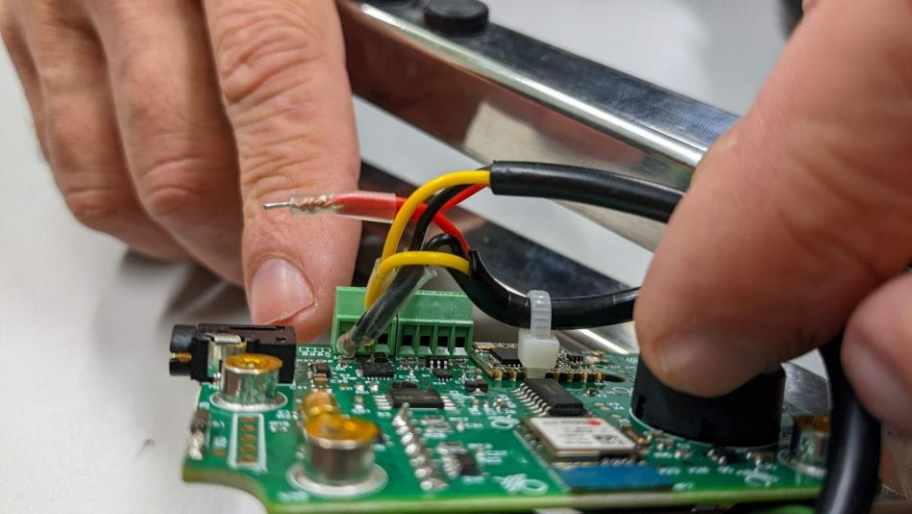
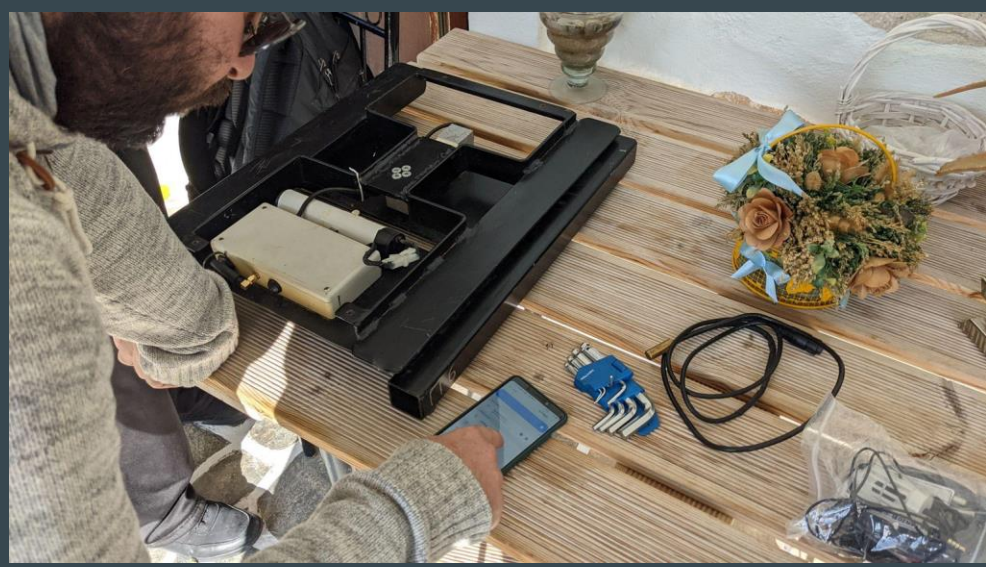
IOT Software & Hardware

www.kudzu.gr

Sensors and weather stations

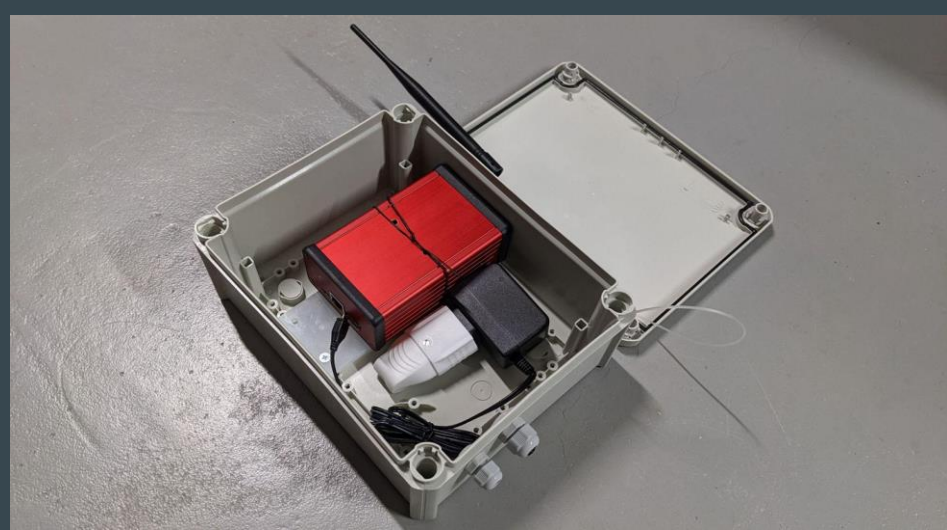


Beekeeping scale as Swiss army knife



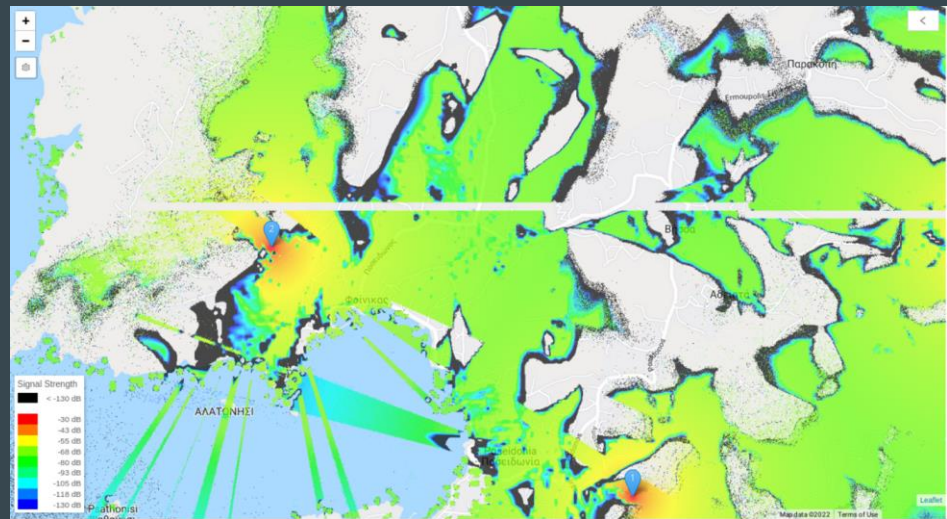
Network Installation Gateways at Syros and Paros island





DIY LoRaWAN Gateways (e.g. RaspberryPi, LoRa Concentrator)

Gateway placement
simulation





Hive management



Search...



XS M XL

IOHIVE (4 members)

Dashboard showing 10 individual hive cards for the IOHIVE group. Each card displays a bar chart, a timestamp, and a status message.

- iohive-athens-goras-01** (IOHIVE: Ath...): Nov 14, 2022 2:03 PM, 11 days ago.
- iohive-paros-pitsikalis-01** (IOHIVE:...): 2 minutes ago, 8 months ago, Hive action.
- iohive-syros-erikos-01 B-GOOD** (I...): check battery, 13 minutes ago, 19 days ago.
- iohive-syros-isdLab-01** (IOHIVE: ISD-L...): check battery, 4 minutes ago, 5 months ago, Device added: aegean-beepbase-005.
- iohive-paros-pitsikalis-02** (IOHIVE:...): 8 months ago, Hive action.
- iohive-syros-dalezios-01** (IOHIVE: Syro...): Aug 6, 2022 12:18 PM, 8 months ago, Device added: kudzu-iohive-002.
- iohive-syros-erikos-02 B-GOOD** (I...): check battery, 15 minutes ago, 19 days ago.
- iohive-syros-isdLab-02** (IOHIVE: iS...): 8 months ago, Hive action.
- iohive-syros-erikos-03 B-GOOD** (I...): check battery, 17 minutes ago, 19 days ago.
- iohive-syros-dalezios-02** (IOHIVE: Syro...): Aug 6, 2022 12:19 PM, 8 months ago, Device removed: kudzu-iohive-001.
- iohive-syros-modestos-01** (IOHIV...): 12 minutes ago, 6 months ago.
- iohive-syros-modestos-02** (IOHIV...): 9 minutes ago, 6 months ago.

IOHIVE-AUA (2 members)

Sensor data visualization (BEEP app)



Hives



Inspections



Data



Alerts

HOURLY

DAY

WEEK

MONTH

YEAR

SELECTION

Relative

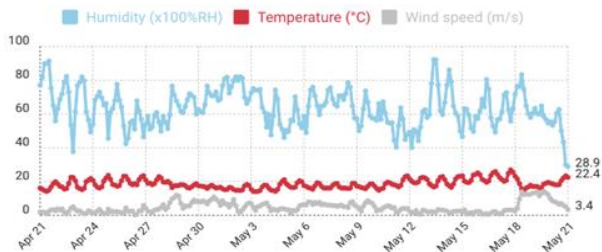
< THU 21 APR 2022 - SAT 21 MAY 2022 /

iohive-syros-erikos-01 B-GOOD - aegean-bgood-01

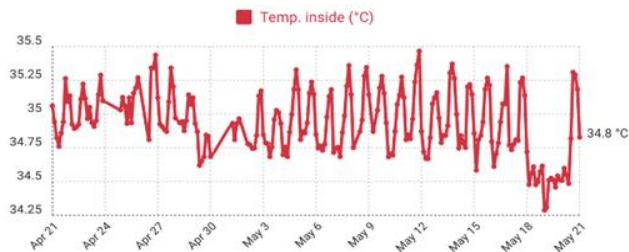
Measurements: iohive-syros-erikos-01 B-GOOD - aegean-bgood-01



WEATHER @ IOHIVE: SYROS-GALISSAS-01 (FROM WEATHER SERVICE)



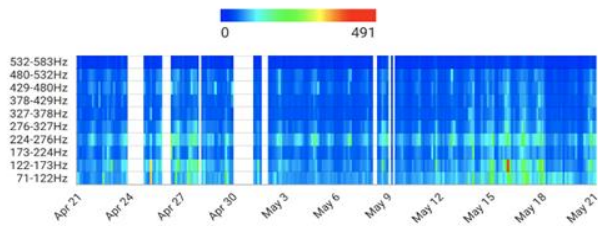
MEASUREMENTS (INTERVAL: 3H)



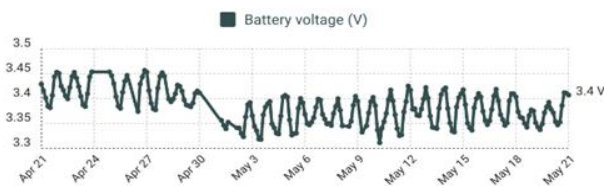
Gewicht gecalibreerd (kg)



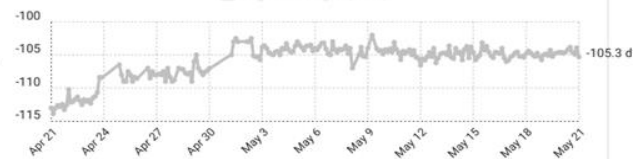
SOUND MEASUREMENTS



DEVICE INFO



Signal strength (dBm)

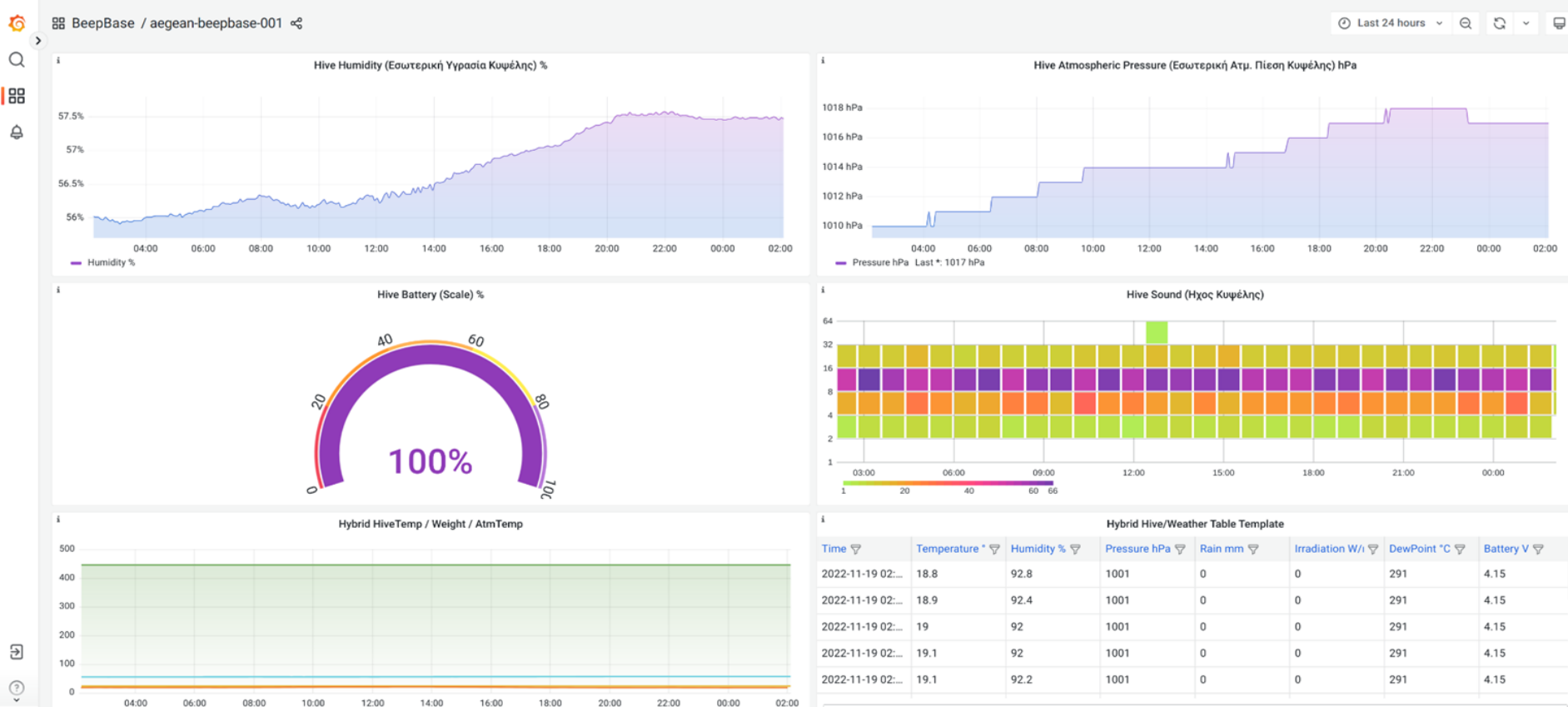


Alerting mechanism

The screenshot displays the BEEP interface with a navigation bar at the top containing 'Hives', 'Inspections', 'Data', and 'Alerts' (with a notification badge for 285). A search bar and 'ALERT RULES' button are located below the navigation bar. The main content area shows a list of five alerts, each with a checkbox on the left, a bell icon, a timeline, a battery level indicator, a location name, an action, and a battery voltage condition.

Alert ID	Timeline	Location	Action	Condition
<input type="checkbox"/>	First: Sun, Nov 20, 2022 6:19 AM Last: Sun, Nov 20, 2022 10:04 AM During 4 hours	iohive-syros-e... aegean-bgood02 IOHIVE: Syros-Galissas-01	check battery	waarde Batterijvoltage = 2.7V (<= 3V)
<input type="checkbox"/>	First: Sun, Nov 20, 2022 6:32 AM Last: Sun, Nov 20, 2022 10:02 AM During 4 hours	iohive-syros-e... aegean-bgood03 IOHIVE: Syros-Galissas-01	check battery	waarde Batterijvoltage = 2.7V (<= 3V)
<input type="checkbox"/>	First: Mon, Nov 14, 2022 11:01 AM Last: Sun, Nov 20, 2022 10:00 AM During 6 days	iohive-syros-i... aegean-beepbase-001 IOHIVE: ISD-Lab	check battery	waarde Batterijvoltage = 2.8V (<= 3V)
<input type="checkbox"/>	First: Sat, Nov 19, 2022 2:06 PM Last: Sun, Nov 20, 2022 9:51 AM During 20 hours	iohive-syros-e... aegean-bgood-01 IOHIVE: Syros-Galissas-01	check battery	waarde Batterijvoltage = 2.8V (<= 3V)
<input type="checkbox"/>	Sun, Nov 20, 2022 7:50 AM 2 hours ago	iohive-syros-e... aegean-beepbase-003 IOHIVE: Syros-Leia-01	check battery	waarde Batterijvoltage = 2.9V (<= 3V)

Extra data visualization (Grafana dashboards)



Inspections



Observation



Intervention



Journaling

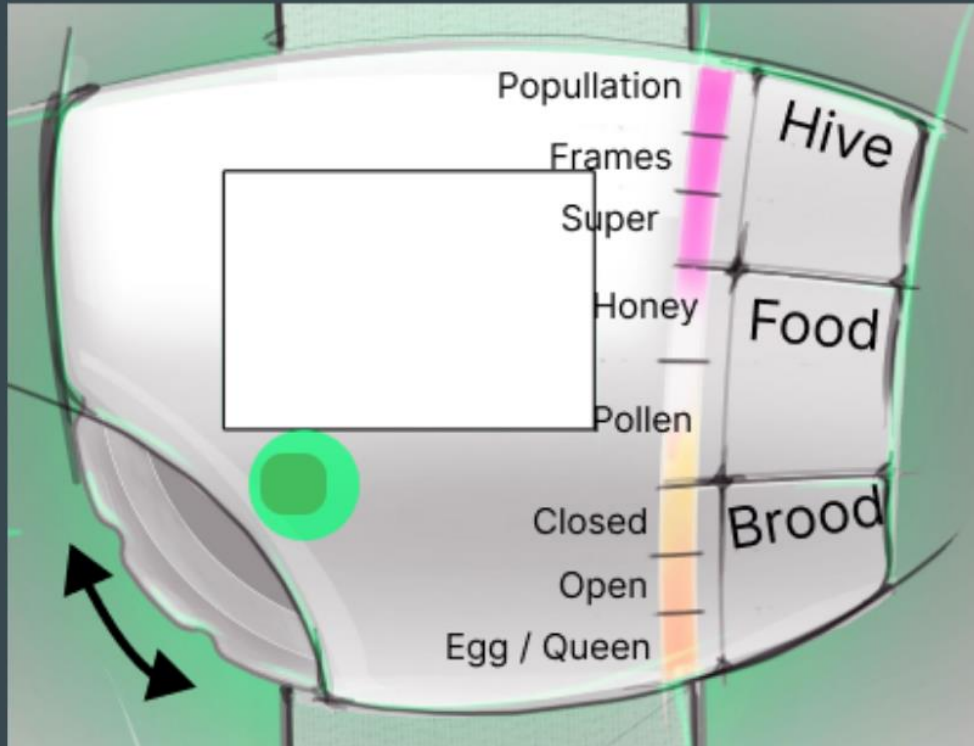


← Inspections iohive-syros-modestos-02

Search...

Inspections	May 19, 2022 11:46 AM	May 7, 2022 9:00 AM	May 4, 2022 8:58 AM	Apr 24, 2022 12:30 PM
Total impression	😊	😊		😊
Needs attention	No	No		No
Notes			Device added: aegean-beepbase-007	Newly Introduced
Remember				
Notification date				
Bee colony				
Bee colony > Brood > Frames with brood	10	10		8
Bee colony > Brood > Presence	Yes	Yes		Yes
Bee colony > Queen > Presence	Yes	Yes		Yes
Bee colony > Size > Frames with bees	20	14		10
Food				
Food > Stock > Honey	Yes	Yes		Yes
Food > Stock > Honey > Number of frames	5	4		2
Food > Stock > Pollen	Yes	Yes		Yes
Food > Stock > Pollen > Number of frames	2	1		0.5

IOHIVE wearable: concept development



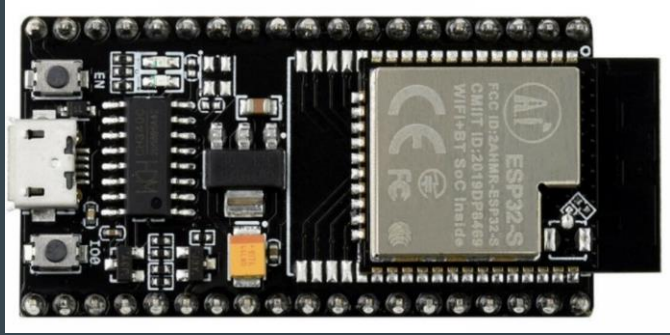
Minimal Inspection Scenario

1. Hive identification
2. Number of frames
3. Frames with food
4. Frames with brood
5. Queen presence
6. Bee population
7. Overall impression
8. Needs attention

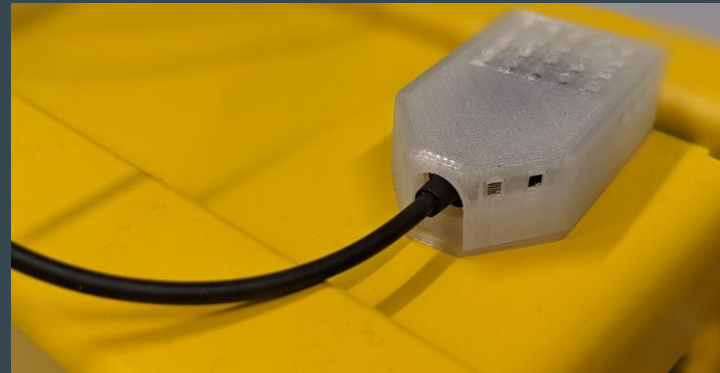
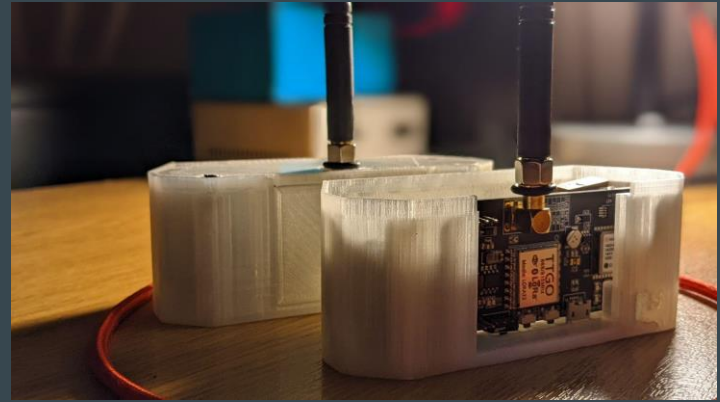
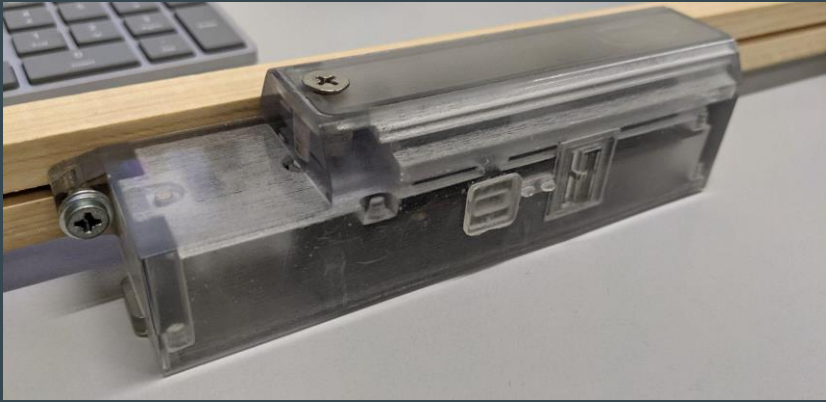
IOHIVE wearable: concept development



IOHIVE wearable: component list



Systems prototyping

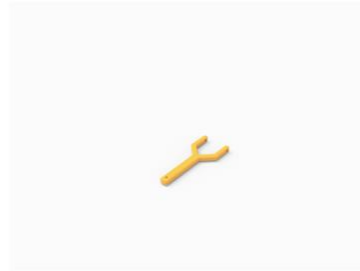


Repository with 3D printable assets (~40 assets)



Home > Digital Repository > 3D assets

3D printable assets



Example of 3D printable assets

Bee Queen Cage IOHIVE



Designed by:

Nikolaos Politopoulos
npol@aegean.gr

Summary

Bee Queen Cage.

Parts

1. Inner - [Download](#)
2. Outer - [Download](#)

Print Settings

Printer: Flashforge Guider 2S

Material: PLA

Rafts: On

Supports: Auto

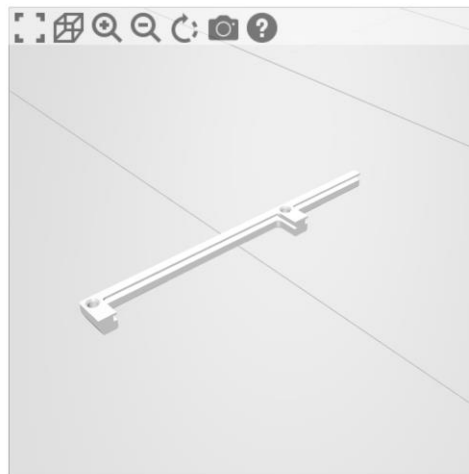
Resolution: Standard

Infill: 15%

Post-Printing

Insert the inner part into the

Hive Modular Door IOHIVE



Designed by:

Nikolaos Politopoulos
npol@aegean.gr

Summary

Hive Modular Door.

Parts

1. Feeder Cap - [Download](#)
2. Gate - [Download](#)
3. Seal+Airflow Cap - [Download](#)
4. Hive Modular Door L - [Download](#)
5. Hive Modular Door R - [Download](#)

Print Settings

Printer: Flashforge Guider 2S

Material: PLA

Rafts: On

Supports: Auto

Resolution: Standard

Infill: 15%

Post-Printing

Print and assemble the door according to model.

Other activities

BEEP

Κυψέλες Επιθεωρήσεις Δεδομένα

Αναζήτηση...

IOHIVE: Paros-Kostos-01

- iohive-paros-pitsikalis-01: 13 λεπτά πριν, 4 μήνες πριν, Hive action
- iohive-paros-pitsikalis-02: 4 μήνες πριν, Hive action

IOHIVE: Syros-Galissas-01

- iohive-syros-erikos-01 B-GO...: 7 λεπτά πριν, 23 μέρες πριν
- iohive-syros-erikos-02 B-GO...: check battery, 8 λεπτά πριν, 23 μέρες πριν
- iohive-syros-erikos-03 B-GO...: check battery, 13 λεπτά πριν, 23 μέρες πριν

Language selection menu:

- Nederlands
- Deutsch
- English
- Français
- Ελληνικά
- Italiano
- Norsk bokmål
- Português
- Română
- Spanish
- Suomi
- Svenska

Αναζήτηση...

- Αποικία μελισσών - μελίσι
- Πληθυσμός
- Χώρος
- Κηφήνες
- Διαίρεση αποικίας κόψιμο μελισσών
- Ενωμένα μελίσι
- Προστέθηκαν μέλισσες
- Απώλεια
- Αφαίρεση
- Δραστηριότητα
- Χαρακτηριστικά
- Πρόληψη σηπουρωγίας
- αντικατάσταση κηρήθρας
- γόνος
- Βασίλισσα
- Μέγεθος
- Τροφή
- Διαταραχή
- Καιρός
- Παραγωγή

WORKER BEE ΕΡΓΑΤΡΙΑ ΜΕΛΙΣΣΑ

Worker bees are female bees that cannot be fertilized. They are responsible for all the work of the hive (honey production, feeding of the queen, larvae and drones, cleaning, etc.).

Οι **εργάτριες μέλισσες** είναι θηλυκές μέλισσες που δεν μπορούν να γονιμοποιηθούν. Είναι υπεύθυνες για όλες τις εργασίες της κυψέλης (την παραγωγή μελιού, την εκτροφή της βασίλισσας, των προνύμφων και των κηφήνων, την καθαριότητα κλπ.).

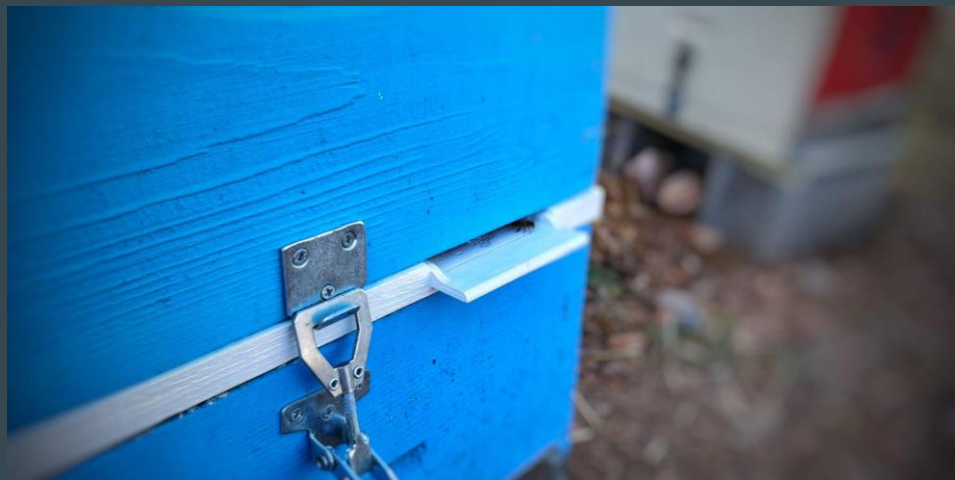
iohive.aegean.gr/glossary/

IOHIVE

f t y

Next steps

- Create open datasets
- Create Data API for researchers
- Wearable implementation and evaluation
- More inspection scenarios
- LoRaWAN on Helium
- Use GIS technology (e.g. blossom areas)
- BeeXML - Exchange data about bees and beekeeping
- Create an open testbed and community



These were only a few examples on how technology can help for sustainable beekeeping.

Beekeeping has long history and carries a rich cultural heritage.

By a multidisciplinary approach, let's discover the most important “worker” of nature, the bee!



Thank you!

v.nomikos@aegean.gr

IOHIVE



Links

- <https://myhive.aegean.gr/>
- <https://iohive.aegean.gr/>
- <https://www.syros.aegean.gr/el>
- <https://www.facebook.com/DPSDE>
- <https://www.facebook.com/isd.aegean>
- <https://www.facebook.com/IOHive>
- <https://www.youtube.com/@iohive1426>
- <https://www.un.org/en/observances/bee-day>
- <https://www.youtube.com/watch?v=el-Z5tgyQXY>
- <https://www.thethingsnetwork.org/>
- <https://github.com/beepnl/BEEP>