



ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΙΓΑΙΟΥ

ΤΜΗΜΑ ΜΗΧΑΝΙΚΩΝ ΠΛΗΡΟΦΟΡΙΑΚΩΝ ΚΑΙ ΕΠΙΚΟΙΝΩΝΙΑΚΩΝ ΣΥΣΤΗΜΑΤΩΝ

Διαδίκτυο των Πραγμάτων

3^ο Εργαστήριο: The Things Network

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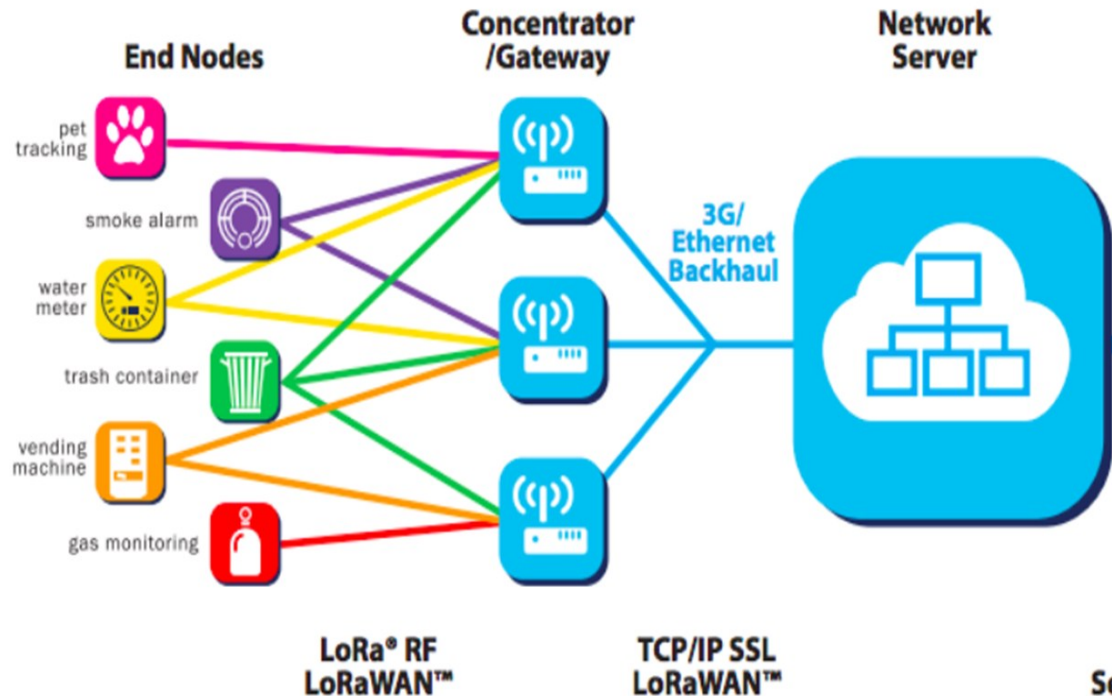
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Περιεχόμενα

- LoRaWAN Network Architecture
- The Things Network (TTN)
- TTN Application
- TTN IoT Device
- Arduino MKR 1300-1310 WAN Microcontroller
- Δραστηριότητα

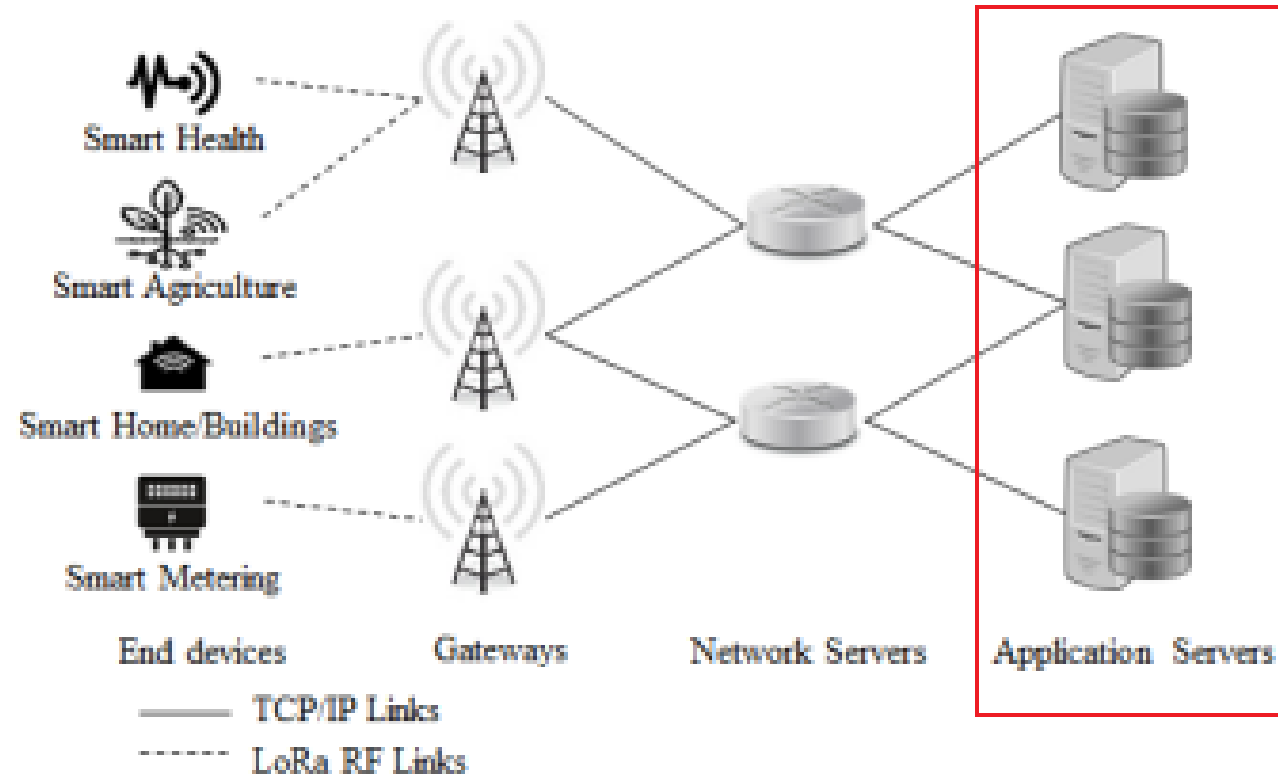
LoRaWAN Network Architecture (1/2)



- Deployed in a star-of-stars topology
- Communication between sensor nodes & BS goes over the wireless channel utilizing LoRa physical layer, whilst the connection between gateways & central server are over a backbone IP-based network
- **End Nodes** transmit directly to all gateways within range, using LoRa
- **Gateways** relay messages between end-devices & central network server using IP



LoRaWAN Network Architecture (2/2)



The Things Network (TTN)



Σύνδεσμος ιστοτόπου : [Link](https://thethingsnetwork.org)



The Things Network (TTN)

The screenshot shows the The Things Network website. The navigation bar includes links for Learn, Hardware, Forum, Communities, Conference, Enterprise, Login, and Sign up. The main content area is divided into two columns. The left column, titled 'Experiment and explore with The Things Network', features a list of benefits and a red-bordered button labeled 'Join The Things Network'. The right column, titled 'Build, grow and scale with The Things Stack Cloud', features a list of benefits and a blue button labeled 'Get started for free'. The background of the website shows a person working on a circuit board.

THE THINGS NETWORK

Learn Hardware Forum Communities Conference Enterprise Login Sign up

Experiment and explore with The Things Network

- ✓ Get hands-on experience with LoRaWAN®
- ✓ Support your local IoT/LoRaWAN community
- ✓ Build and participate in community projects
- ✗ Fair usage policy applies (not suitable for businesses)
- ✗ May experience occasional downtimes with no high availability

Join The Things Network

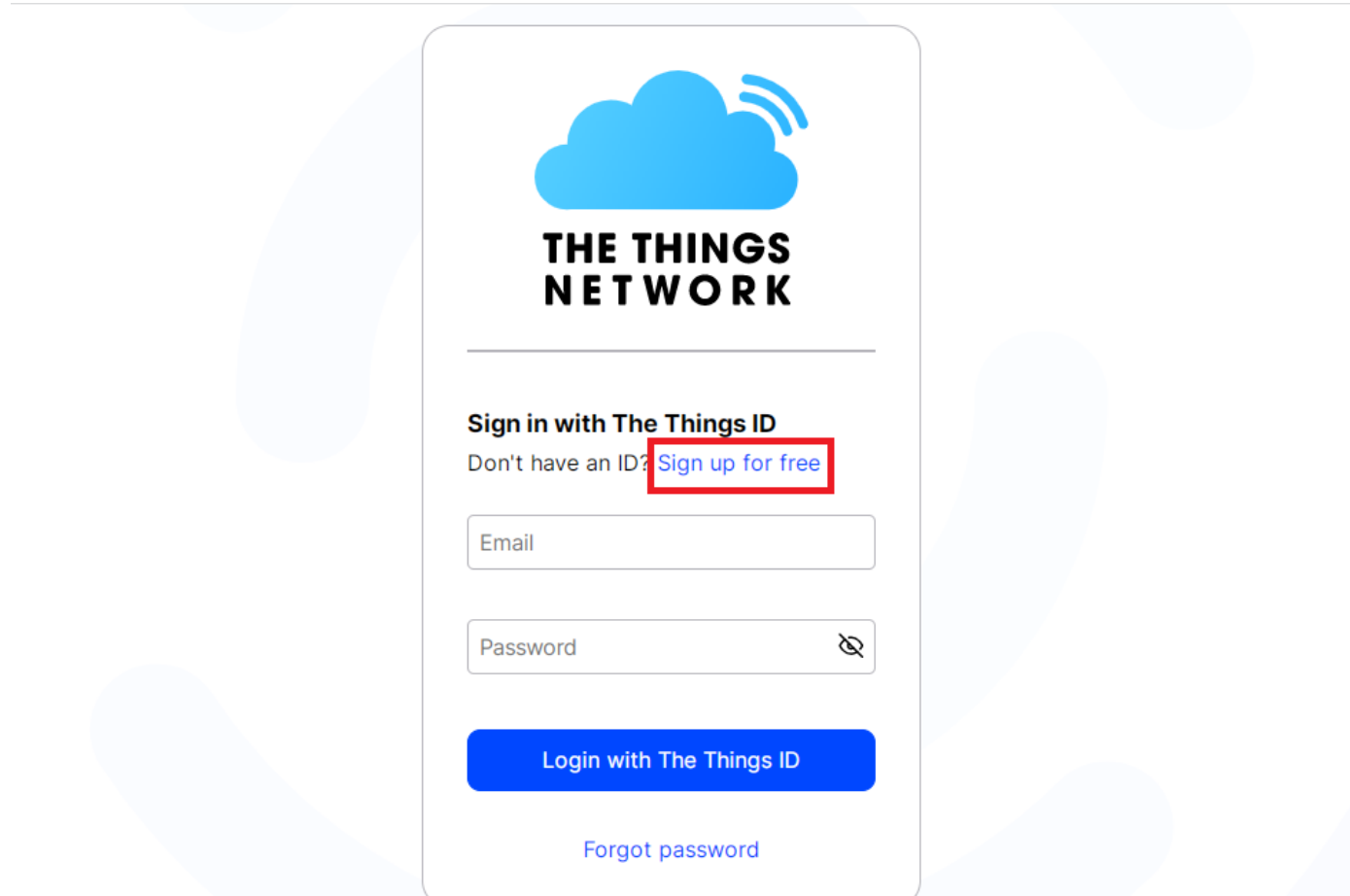
Build, grow and scale with The Things Stack Cloud

- ✓ Out-of-the-box LoRaWAN® Network Server
- ✓ 100% private, secure and isolated network
- ✓ Suitable for commercial, industrial use
- ✓ >99.9% guaranteed uptime
- ✓ Advanced network management features
- ✓ Pays-as-you-go pricing plans

Get started for free



The Things Network (TTN)



The image shows a mobile-style login and sign-up interface for The Things Network. At the top is a blue cloud icon with three signal waves. Below it, the text "THE THINGS NETWORK" is displayed in bold. A horizontal line separates the header from the sign-in section. The sign-in section is titled "Sign in with The Things ID". Below this title, the text "Don't have an ID?" is followed by a blue link "Sign up for free", which is highlighted with a red rectangular box. Underneath are two input fields: "Email" and "Password". The "Password" field has a small eye icon to its right. Below the input fields is a blue button labeled "Login with The Things ID". At the bottom of the form is a blue link labeled "Forgot password".


**THE THINGS
NETWORK**

Sign in with The Things ID
Don't have an ID? [Sign up for free](#)

Email

Password 

[Login with The Things ID](#)

[Forgot password](#)



The Things Network (TTN)



THE THINGS ID

Create one ID to get access to all our products.

One secure account for The Things Network and future services gathered in one place.



Username •

Email •

Password •

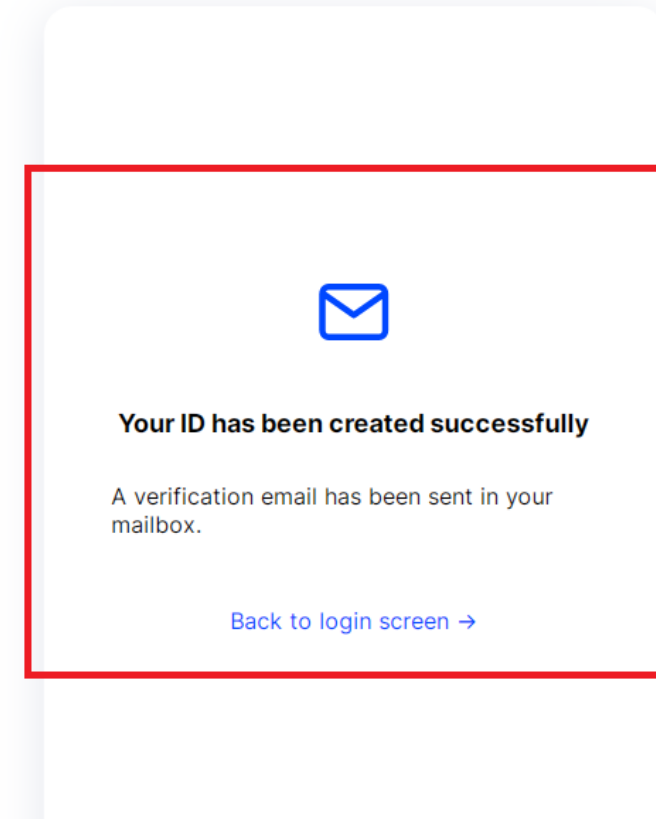
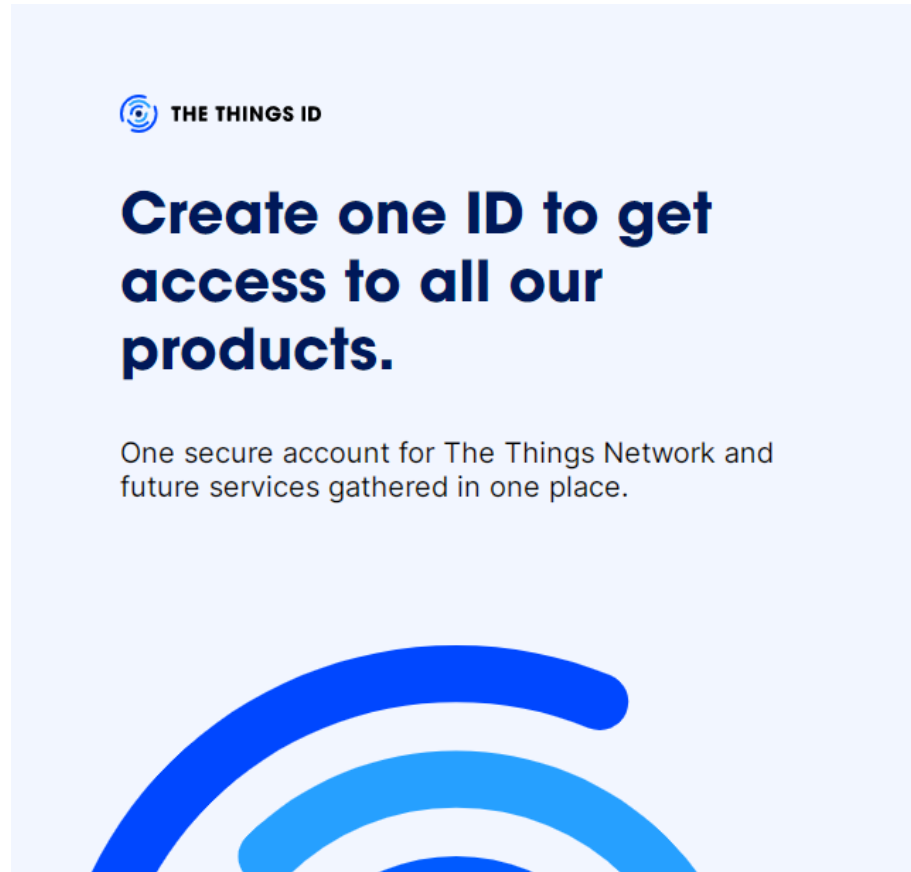
Confirm Password •

☒ By checking this box, you agree to our [Terms and Conditions](#) and [Privacy Policy](#).

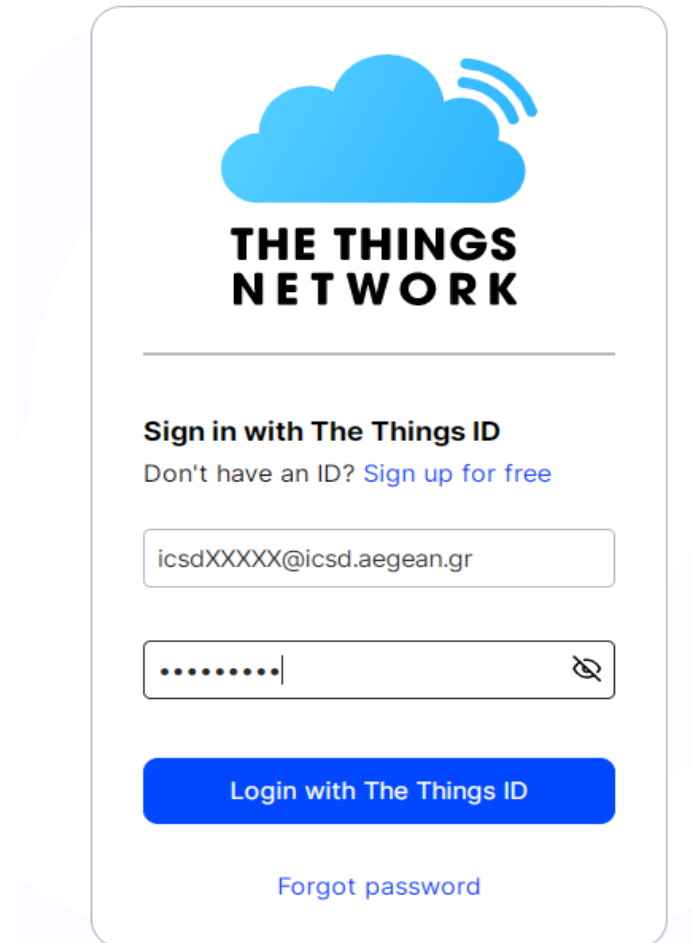
Sign up to The Things ID



The Things Network (TTN)



The Things Network (TTN)



The image shows a login interface for The Things Network. At the top is a blue cloud icon with three curved lines representing a signal. Below it, the text "THE THINGS NETWORK" is displayed in bold, black, uppercase letters. A horizontal line separates the header from the login section. The login section starts with the text "Sign in with The Things ID" in bold, followed by "Don't have an ID? [Sign up for free](#)". Below this is a text input field containing the email address "icsdXXXXX@icsd.aegean.gr". Underneath the email field is a password input field with a series of dots and a toggle icon on the right. A blue button with the text "Login with The Things ID" is positioned below the password field. At the bottom of the login section is a link that says "Forgot password".

THE THINGS NETWORK

Sign in with The Things ID
Don't have an ID? [Sign up for free](#)

icsdXXXXX@icsd.aegean.gr

.....

Login with The Things ID

[Forgot password](#)



The Things Network (TTN)



THE THINGS NETWORK

Learn Hardware Forum Communities Conference **Enterprise**

leftsipis ▾

- My Profile
- Console**
- Log Out

We are a global collaborative Internet of Things ecosystem that creates networks, devices and solutions using LoRaWAN®.

[Start building](#) [Learn more](#)



The Things Network (TTN)

The Things Stack Community Edition
Choose a network cluster

Device or gateway location
Select your region

Existing clusters

- Europe 1**
eu1 – Dublin, Ireland
- North America 1**
nam1 – California, USA
- Australia 1**
au1 – Sydney, Australia



The Things Network (TTN)



Welcome back, gregpapsamos! 🖐️

Walk right through to your applications and/or gateways.

Need help? Have a look at our [Documentation](#) or [Get support](#).



[Go to applications](#)



[Go to gateways](#)



The Things Network (TTN)

The screenshot displays the TTN web interface for a gateway named 'samos-aegean-iot'. The interface includes a top navigation bar with 'Overview', 'Applications', 'Gateways', and 'Organizations'. The 'Gateways' tab is selected. On the left, a sidebar shows the gateway's name and navigation options: 'Overview', 'Live data', 'Location', 'Collaborators', 'API keys', and 'General settings'. The main content area shows the gateway's details:

- General information:**
 - Gateway ID: `eu1-ac1f09fffe0607b6`
 - Gateway EUI: `AC 1F 09 FF FE 06 07 B6`
 - Gateway description: None
 - Created at: Oct 1, 2022 11:19:09
 - Last updated at: Oct 1, 2022 11:54:35
 - Gateway Server address: `eu1.cloud.thethings.network`
- LoRaWAN information:**
 - Frequency plan: `EU_863_870_TTN`
 - Global configuration: [Download global_conf.json](#)
- Live data:** A list of recent messages with timestamps and details like Tx Power, Data rate, and DevAddr.
- Location:** A map showing the gateway's location in the Aegean Sea region, with labels for 'Καρόβρα', 'Παραποταμή Ένδρα', 'Μυτιλήνη', and 'Ιάρος'.

At the bottom left, there is a 'Hide sidebar' button.



TTN Application



Welcome back, gregpapsamos! 🖐️

Walk right through to your applications and/or gateways.

Need help? Have a look at our [Documentation](#) or [Get support](#).



Go to applications



Go to gateways



TTN Application

The screenshot shows the TTN Applications management interface. At the top, there's a navigation bar with the TTN logo, 'THE THINGS STACK Community Edition', and tabs for Overview, Applications (selected), Gateways, and Organizations. On the right, it shows 'EU1 Community' with a note 'Fair use policy applies' and a user profile 'leftsipis'. Below the navigation bar, the main content area is titled 'Applications (0)' and contains a search bar and a '+ Add application' button, which is highlighted with a red rectangle. Below this is a table header with columns: ID, Name, End devices, and Created at. The table body is empty, displaying 'No items found'.

THE THINGS NETWORK

THE THINGS STACK
Community Edition

Overview Applications Gateways Organizations

EU1 Community
Fair use policy applies

leftsipis

Applications (0)

Search

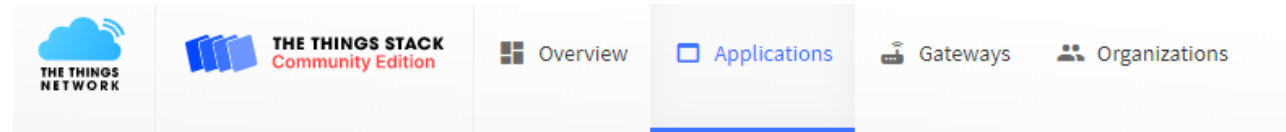
+ Add application

ID Name End devices Created at

No items found



TTN Application



Add application

Application ID *

Application name

Description

Optional application description; can also be used to save notes about the application

Create application



TTN IoT Device

tsipisdemoapp

Overview

End devices

Live data

Payload formatters

Integrations

Collaborators

API keys

General settings

tsipisdemoapp

ID: tsipisdemoapp

No recent activity

0 End devices 1 Collaborator 0 API keys

General information

Application ID

tsipisdemoapp

Created at

Nov 4, 2022 18:41:35

Last updated at

Nov 4, 2022 18:41:35

End devices (0)

ID

Name

DevEUI

JoinEUI

Last activity

Live data

18:41:35 tsipisdemo... Create application

See all activity

Search

Import end devices

Add end device

TTN IoT Device

The screenshot displays the TTN IoT Device web interface. At the top, the header includes the TTN logo, 'THE THINGS STACK Community Edition', navigation tabs for Overview, Applications (selected), Gateways, and Organizations, and user information for 'EU1 Community' and 'leftsipis'. The left sidebar shows the application 'tsipisdemoapp' and its sub-menu items: Overview, End devices (selected), Live data, Payload formatters, Integrations, and Collaborators. The main content area shows the 'End devices' page for 'tsipisdemoapp', with a search bar, an 'Import end devices' button, and a highlighted '+ Add end device' button. Below these elements is a table with columns for ID, Name, DevEUI, JoinEUI, and Last activity, which currently displays 'No items found'.

Applications > tsipisdemoapp > End devices

End devices (0)

Search

Import end devices

+ Add end device

ID	Name	DevEUI	JoinEUI	Last activity
No items found				



TTN IoT Device

tsipisdemoapp

Overview

End devices

Live data

Payload formatters

Integrations

Collaborators

API keys

General settings

< Hide sidebar

End device type

Input Method

☐ Select the end device in the LoRaWAN Device Repository

☒ Enter end device specifics manually

Frequency plan [?]*

Europe 863-870 MHz (SF9 for RX2 - recommended) | v

LoRaWAN version [?]*

LoRaWAN Specification 1.0.1 | v

Regional Parameters version [?]*

TS001 Technical Specification 1.0.1 | v

Show advanced activation, LoRaWAN class and cluster settings v

Provisioning information

JoinEUI [?]*

00 00 00 00 00 00 00 00 | Confirm

←

←

←

←

TTN IoT Device

tsipisdemoapp

Overview

End devices

Live data

Payload formatters

Integrations

Collaborators

API keys

General settings

< Hide sidebar

Provisioning information

JoinEUI ⓘ *

00 00 00 00 00 00 00 00

Reset

This end device can be registered on the network

DevEUI ⓘ *

70 B3 D5 7E D0 05 73 A8

Generate

5/50 used

AppKey ⓘ *

DB DF 17 72 02 A2 C7 46 80 93 F0 D4 80 EB 2A BA

Generate

End device ID ⓘ *

eui-70b3d57ed00573a6

This value is automatically prefilled using the DevEUI

After registration

☒ View registered end device

☐ Register another end device of this type

Register end device



TTN IoT Device

The screenshot displays the TTN IoT Device management interface. The top navigation bar includes the TTN logo, 'THE THINGS STACK Community Edition', and tabs for Overview, Applications (selected), Gateways, and Organizations. The right side shows the 'EU1 Community' with a 'Fair use policy applies' note and a user profile 'leftsipis'. The left sidebar lists 'tsipisdemoapp' with sub-items: Overview, End devices (selected), Live data, and Payload formatters. The main content area shows the path 'Applications > tsipisdemoapp > End devices'. It features a search bar, 'Import end devices', and 'Add end device' buttons. A table lists end devices with columns: ID, Name, DevEUI, JoinEUI, and Last activity. One device is listed: 'eui-70b3d57ed00573a6' with DevEUI '70 B3 D5 7E D0 05 73 A8' and JoinEUI '00 00 00 00 00 00 00 00'. The last activity is 'Never'.

ID	Name	DevEUI	JoinEUI	Last activity
eui-70b3d57ed00573a6		70 B3 D5 7E D0 05 73 A8	00 00 00 00 00 00 00 00	Never



TTN IoT Device

The screenshot shows the TTN IoT Device management interface. On the left is a sidebar with navigation links: Overview, End devices (selected), Live data, Payload formatters, Integrations, Collaborators, API keys, and General settings. The main content area is for the device **eui-70b3d57ed00573a6** (ID: eui-70b3d57ed00573a6). It features tabs for Overview, Live data, Messaging, Location, Payload formatters, Claiming, and General settings. The Overview tab is active, showing General information and Activation information. The Activation information section is highlighted with a red box and contains fields for AppEUI (00 00 00 00 00 00 00 00), DevEUI (70 B3 D5 7E D0 05 73 A8), and AppKey (a masked key). To the right of the General information is a Live data section with a 'See all activity' link and a log entry for 18:53:43 'Create end device'. At the bottom right is a Location section with a map and a 'Change location settings' link.

tsipisdemoapp

eui-70b3d57ed00573a6
ID: eui-70b3d57ed00573a6

↑ n/a ↓ n/a • No activity yet ?

[Overview](#) [Live data](#) [Messaging](#) [Location](#) [Payload formatters](#) [Claiming](#) [General settings](#)

General information

End device ID: eui-70b3d57ed00573a6

Frequency plan: Europe 863-870 MHz (SF9 for RX2 - recom...)

LoRaWAN version: LoRaWAN Specification 1.0.1

Regional Parameters version: TS001 Technical Specification 1.0.1

Created at: Nov 4, 2022 18:53:43

Activation information

AppEUI: 00 00 00 00 00 00 00 00

DevEUI: 70 B3 D5 7E D0 05 73 A8

AppKey:

Live data [See all activity →](#)

18:53:43 Create end device

Location [Change location settings →](#)

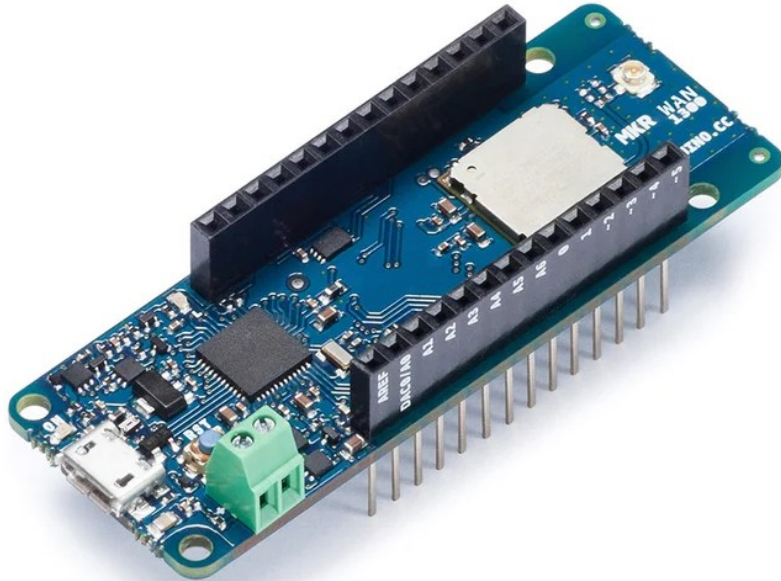


Arduino MKR 1300-1310 WAN Microcontroller

- Το Arduino MKR WAN 1300 ήταν η πρώτη πλακέτα LoRa® που κυκλοφόρησε από την Arduino, ως μια πρακτική και οικονομικά αποδοτική λύση με ελάχιστες απαιτήσεις ισχύος.
- Το Arduino MKR WAN 1300 μπορεί να συνδεθεί με :
 - Arduino IoT Cloud
 - The Things Network
 - Άλλες πλακέτες χρησιμοποιώντας τη λειτουργία άμεσης συνδεσιμότητας.



Arduino MKR 1300-1310 WAN Microcontroller



Board	Name	Arduino® MKR WAN 1300
Current Rating	DC Current 5V pin (powered via USB/VIN)	depends on power supply
	Processor	48 MHz
Clock speed	RTC	32.768 kHz
	Memory	SAMD21G18A
		256KB Flash, 32KB SRAM

Περισσότερες πληροφορίες:

<https://docs.arduino.cc/hardware/mkr-wan-1300>



Arduino MKR 1300-1310 WAN (Δραστηριότητα)

Καλείστε να χρησιμοποιήσετε τον κώδικα που σας έχει δοθεί στο Eclass στον φάκελο “εργαστήριο” στην 3^η άσκηση κατεβάστε τον κώδικα “send data mkrwan”

- Απαραίτητη προϋπόθεση για να ανεβάσουμε τα δεδομένα στο TTN μέσω του MKR-1300-1310, είναι ο εντοπισμός του Device EUJ που είναι μοναδικός κωδικός (π.χ. serial number).
- Αφού εκτελέσουμε τον κώδικα όπως είναι, στο serial monitor θα μας εμφανίσει το device EUJ

```
Output  Serial Monitor  x
Message (Ctrl + Enter to send message to 'Arduino MKR WAN 1300' on 'COM6')

13:44:59.202 -> Welcome to MKRWAN1300/1310 first configuration sketch
13:44:59.202 -> Register to your favourite LoRa network and we are ready to go!
13:44:59.943 -> Your module version is: ARD-078 1.1.5
13:44:59.943 -> Your device EUJ is: a8610a323339910c
13:46:01.006 -> Something went wrong; are you indoors? Move near a window and retry
```



Arduino MKR 1300-1310 WAN

Σε περίπτωση που δεν εντοπίζουμε το board **Arduino MKR WAN 1300-1310** στο Arduino IDE

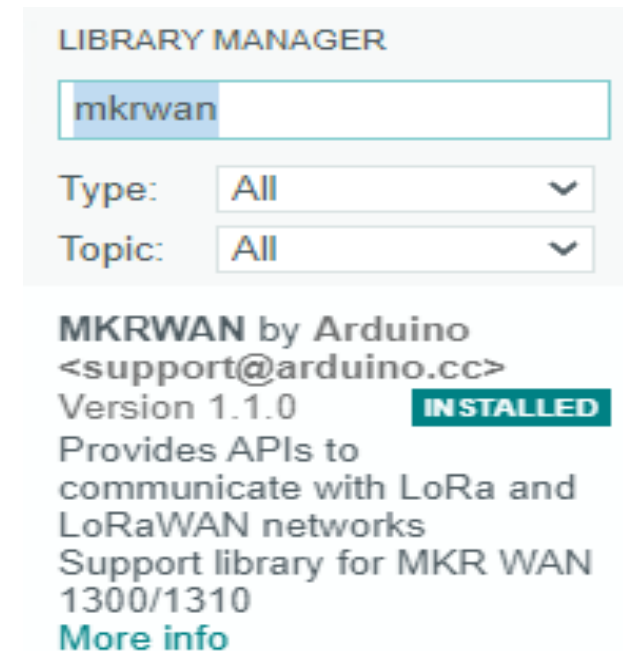
- Κατευθυνόμαστε στην ενότητα **Tools -> Board -> Boards Manager**
- Επιλέγουμε από τον κατάλογο να εγκαταστήσουμε το “**Arduino SAMD Boards(32-bits ARM Cortex-M10+)**”
- Αφού εγκατασταθεί επιλέγουμε από την ενότητα **Tools -> Board -> Arduino SAMD Boards(32-bits ARM Cortex-M10+)-> Arduino MKR WAN 1300-1310**



Arduino MKR 1300-1310 WAN

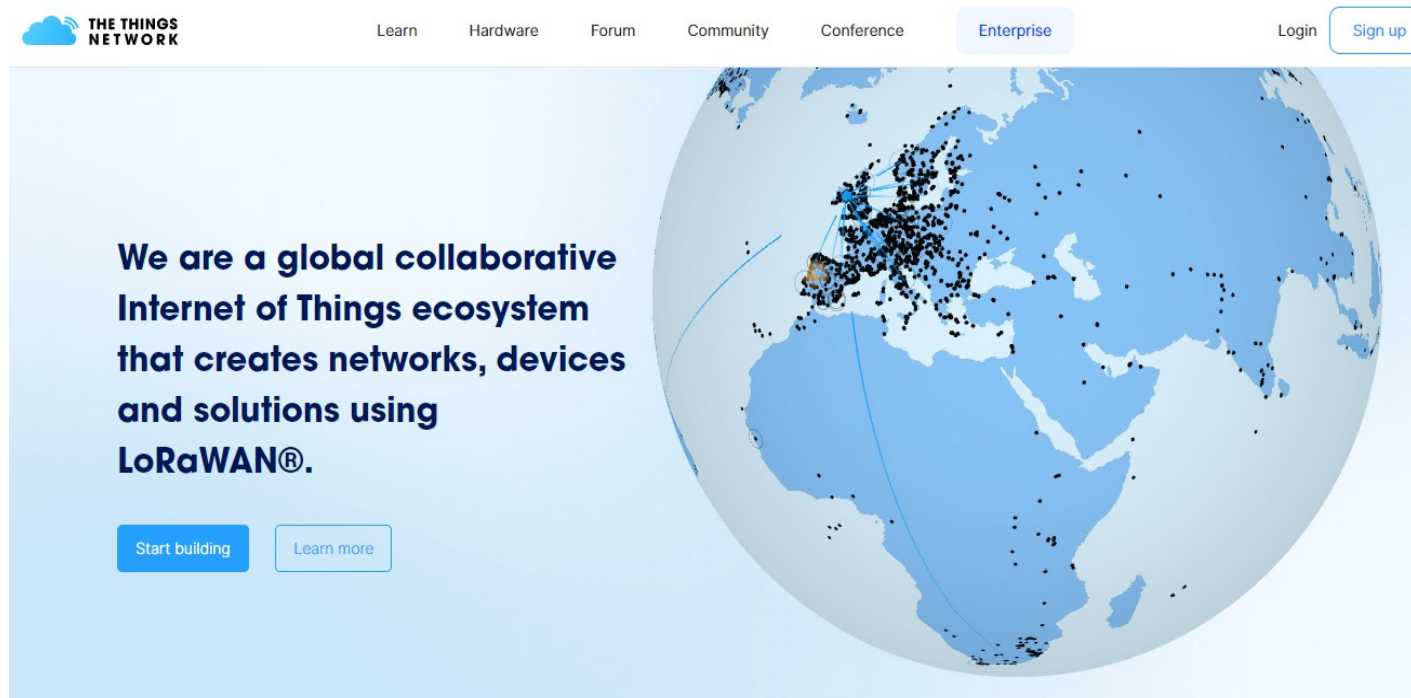
Εκτός από τα drivers του Board που εγκαταστήσαμε προηγουμένως, είναι απαραίτητο να εγκαταστήσουμε και τη βιβλιοθήκη «MKRWAN.h» προκειμένου να προγραμματίσουμε το board μας.

- Κατευθυνόμαστε στο **Sketch-> Include Library-> Manage Libraries**
- Στο Παράθυρο που μας ανοίγει στο search bar γράφουμε **mkrwan**
- Επιλέγουμε το **MKRWAN by Arduino** και το εγκαθιστούμε.



Arduino MKR 1300-1310 WAN (Δραστηριότητα)

- Αφού βρήκαμε το device EUI κατευθυνόμαστε στο TNN προκειμένου να φτιάξουμε νέο application



Σύνδεσμος ιστοτόπου : [Link](#)



TTN IoT Device

 tsipisdemoapp

 Overview

 End devices

 Live data

 Payload formatters

 Integrations

 Collaborators

 API keys

 General settings

Provisioning information

JoinEUI ⓘ *

00 00 00 00 00 00 00 00 Reset

This end device can be registered on the network

DevEUI ⓘ *

70 B3 D5 7E D0 05 73 A8 Generate 5/50 used

AppKey ⓘ *

DB DF 17 72 02 A2 C7 46 80 93 F0 D4 80 EB 2A BA Generate

End device ID ⓘ *

eui-70b3d57ed00573a6

This value is automatically prefilled using the DevEUI

After registration

☒ View registered end device

☐ Register another end device of this type

Register end device

Προσοχή!
Γράφουμε
προσεκτικά το Dev
EUI που βρήκαμε
προηγουμένως



TTN IoT Device

The screenshot displays the TTN IoT Device management interface. The top navigation bar includes the TTN logo, 'THE THINGS STACK Community Edition', and tabs for Overview, Applications (selected), Gateways, and Organizations. On the right, it shows 'EU1 Community' with a 'Fair use policy applies' note and a user profile 'leftsipis'. The left sidebar for the 'tsipisdemoapp' application lists Overview, End devices (selected), Live data, and Payload formatters. The main content area shows the 'End devices' list for 'tsipisdemoapp'. A search bar and buttons for 'Import end devices' and 'Add end device' are at the top. A table lists the end devices, with one device highlighted by a red box:

ID	Name	DevEUI	JoinEUI	Last activity
eui-70b3d57ed00573a6		70 B3 D5 7E D0 05 73 A8	00 00 00 00 00 00 00 00	Never



TTN IoT Device

The screenshot displays the TTN IoT Device management interface. On the left is a sidebar with navigation options: Overview, End devices (selected), Live data, Payload formatters, Integrations, Collaborators, API keys, and General settings. The main content area shows the device details for **eui-70b3d57ed00573a6** (ID: eui-70b3d57ed00573a6). At the top, it indicates 'No activity yet'. Below this are tabs for Overview, Live data, Messaging, Location, Payload formatters, Claiming, and General settings. The 'Overview' tab is active, showing 'General information' and 'Activation information'. The 'General information' section includes fields for End device ID, Frequency plan (Europe 863-870 MHz), LoRaWAN version (1.0.1), Regional Parameters version (TS001), and Created at (Nov 4, 2022 18:53:43). The 'Activation information' section, highlighted with a red box, includes AppEUI (00 00 00 00 00 00 00), DevEUI (70 B3 D5 7E D0 05 73 A8), and AppKey (masked with dots). To the right of the 'General information' is a 'Live data' section with a 'See all activity' link and a log entry at 18:53:43: 'Create end device'. Below the 'Activation information' is a 'Location' section with a 'Change location settings' link and a map of Europe.

tsipisdemoapp

Overview

End devices

Live data

Payload formatters

Integrations

Collaborators

API keys

General settings

eui-70b3d57ed00573a6
ID: eui-70b3d57ed00573a6

↑ n/a ↓ n/a • No activity yet

Overview Live data Messaging Location Payload formatters Claiming General settings

General information

End device ID eui-70b3d57ed00573a6

Frequency plan Europe 863-870 MHz (SF9 for RX2 - recom...

LoRaWAN version LoRaWAN Specification 1.0.1

Regional Parameters version TS001 Technical Specification 1.0.1

Created at Nov 4, 2022 18:53:43

Activation information

AppEUI 00 00 00 00 00 00 00

DevEUI 70 B3 D5 7E D0 05 73 A8

AppKey

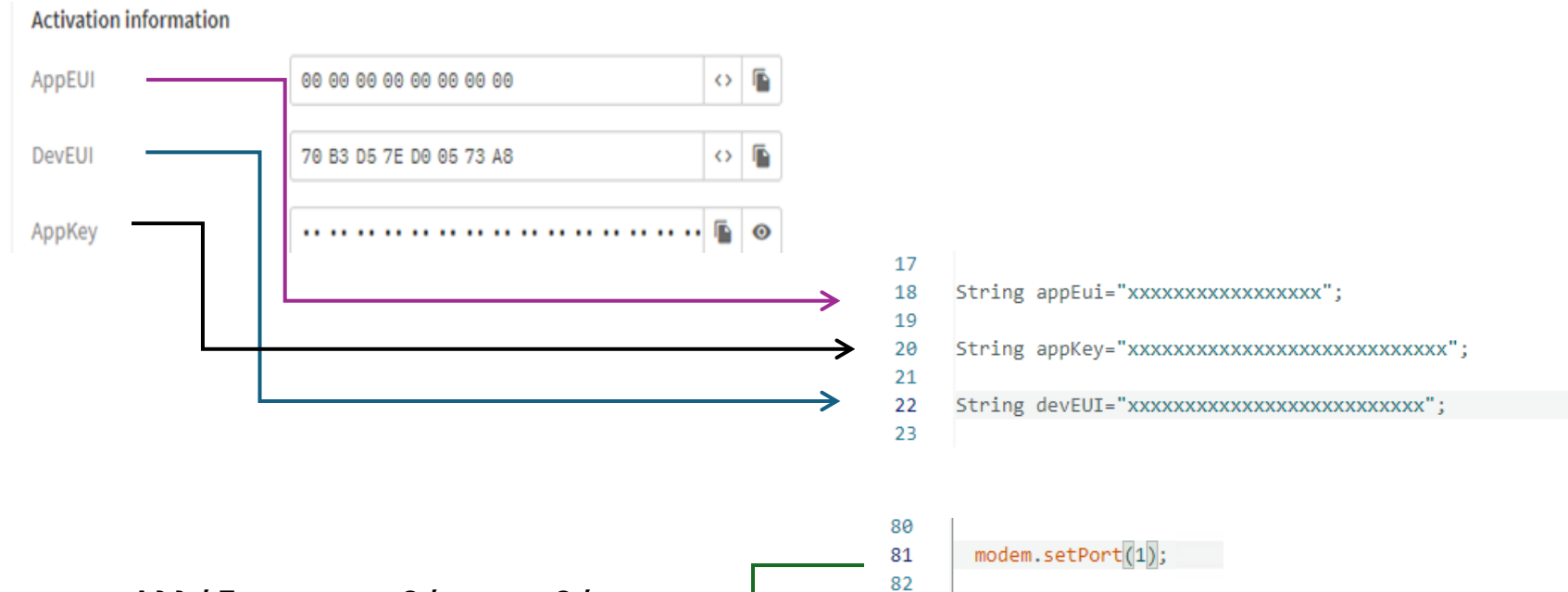
Live data See all activity →

18:53:43 Create end device

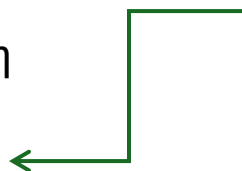
Location Change location settings →



Δραστηριότητα



Αλλάζουμε την θύρα με βάση
τον υπολογιστή που
βρισκόμαστε π.χ. (1^{ος}
υπολογιστής από πάνω
αριστερά port =1)



Δραστηριότητα

Αφού τροποποιήσετε τον κώδικα κατάλληλα με βάση την προηγούμενη διαφάνεια, ανεβάστε τον κώδικα στο Board.

- **Τι παρατηρείτε στην καρτέλα Live Data στο TTN ;**



Δραστηριότητα

Προκειμένου να αποκωδικοποιήσουμε το μήνυμα που στείλαμε πρέπει να τροποποιήσουμε τον payload formatter:

```
function decodeUplink(input)
{ return { data: { number: input.bytes[0] }
, warnings: [], errors: [] }}
```

 **eui-a8610a323339910c**
ID: eui-a8610a323339910c

↑ 1 ↓ 1 • Last activity 7 seconds ago ⓘ

Overview Live data Messaging Location Payload formatters Claiming General settings

Time	Type	Data preview
↓ 15:14:56	Schedule data downlink for t...	DevAddr: 26 0B 41 75 <> Rx1 Delay: 5
↑ 15:14:55	Forward uplink data message	DevAddr: 26 0B 41 75 <> Payload: { number: 12 } 0C <>
↑ 15:14:55	Successfully processed data ...	DevAddr: 26 0B 41 75 <>

