GLAMOS Walker – instructions for use (rev5)

1. Introduction

GLAMOS Walker is most advanced and most user-friendly LoRaWAN testing tool on the market. It enables testing network coverage, signal quality, find best place for gateway (hotspot) and sensor installation.

You got device in your hard case which allows you to carry it around safely.
Package includes device Walker, 3 antennas and USB cable.

Antennas:

- large (L) – 2.15 dBi
- medium (M) – 1 dBi
- small (S) – 0 dBi

USB cable is provided for charging device with 5V DC and for flashing new firmware versions.

Content

2. Basic terms – keywords

Radio frequency (RF) – way to generate electromagnetic waves and transfer energy. We are manipulating RF with radio which can be hardware defined and software defined. Hardware defined is part of generating EM waves and software defined is part of encoding/decoding and (de)modulation of data. Modulation is algorithm which defines how data/messages/bits will be transferred to RF energy. Key RF parameters are frequency, amplitude and phase. Symbol is discrete energy state which represent some quantity of information.

LoRa - an RF modulation technology for low-power wide area networks (LPWANs). The name, LoRa, is a reference to the extremely long-range data links that this technology enables. Created by Semtech to standardize LPWANs, LoRa provides for long-range communications: up to 5 kilometers (3 miles) in urban areas, and up to 15 kilometers (10 miles) or more in rural areas (line of sight). A key characteristic of the LoRa-based solutions is ultra-low power requirements, which allows for the creation of battery-operated devices that can last for up to 10 years.

LoRa is purely a physical (PHY), or "bits" layer implementation, as defined by the OSI seven-layer Network Model. Instead of cabling, the air is used as a medium for transporting LoRa radio waves from an RF transmitter in an IoT device to an RF receiver in a gateway, and vice versa.

LoRa operates in unlicensed spectrum which is called ISM band (industry, science and medical). Each state has a law that decides which frequency band is free to use. In EU it works on 863-870MHz and 433MHz, in US 902-928MHz, in AU 915-928MHz, in AS 923MHz, in CN 470-510MHz. Plan by country find at: https://www.thethingsnetwork.org/docs/lorawan/frequencies-by-country/

LoRaWAN – this is "MAC" layer implementation of LoRa, but with some rules and laws which are provided by LoRa Alliance. So LoRaWAN is one layer above LoRa layer.

LoRa provides physical transport of message through air (**wireless communication**). LoRaWAN is an open standard that adds the MAC, networking and application layers that provide required functionalities like managing medium access, security and so on.

There is no one-to-one relationship between LoRa-based devices and gateways in a LoRaWAN network. Messages sent to and from end devices travel through all gateways within range (see Figure 1). Deduplication is handled by the network server.

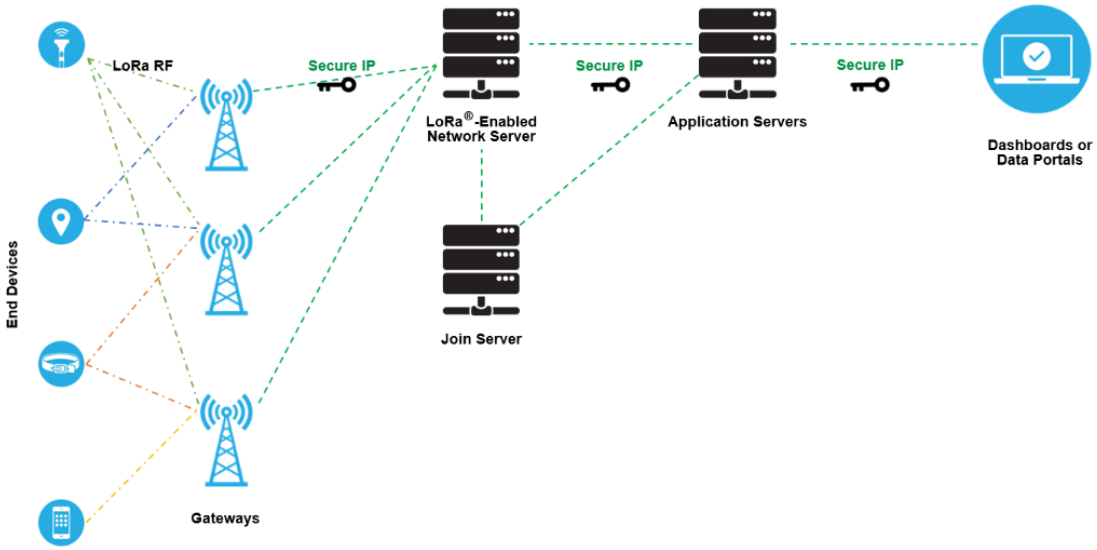


Figure 1 Typical LoRaWAN network implementation

Gateways listen in 8 frequencies simultaneously, in every spreading factor at each frequency. Collisions prevented by maximum duty cycle limitations per frequency If nevertheless, there is a collision, the strongest packet prevails.

In terms of downlink messages all the gateways in a network are tied back to the same server, it's the server's job to decide which gateway should respond to a transmission. In a large network, any given transmission is typically heard by multiple receivers; the server then tells one gateway to respond and the others to ignore the transmission. This process helps avoid downlink and uplink collisions, because a single gateway is transmitting, and the gateways that are overlapping can simply listen for other transmissions.

Activation of end device – LoRaWAN enables OTAA and ABP activation of end node.

*Over-The-Air-Activation (**OTAA**)* - the most secure activation method for end devices. Devices perform a join procedure with the network, during which a dynamic device address is assigned, and security keys are negotiated with the device. *NOTE: Helium supports just OTAA, not ABP.*

*Activation By Personalization (**ABP**)* - requires hardcoding the device address as well as the security keys in the device. ABP is less secure than OTAA and has the downside that devices can't switch network providers without manually changing keys in the device. *NOTE: Helium doesn't support ABP.*

JOIN procedure – procedure which is needed for OTAA and should be completed before end nodes start to transmit messages with wanted information. During this process end node and LoRaWAN server will exchange some keys. This communication is done with help of gateways who are bridge between.

End node will send Join Request which includes its unique keys. Gateway will transfer message to LoRaWAN server. Server (TTN, Helium or any other) will check does that device exist in network, at some of user's profiles. If keys exist, server will give command to gateway, to send Join Accept to end node. Then Join Accept includes some parameters and new keys that are needed to keep communication. If Join is successful, they will keep exchanging messages as Uplinks and Downlinks.

This is like when you come to football match or concert (sent Join request). Guys at entrance (gateway) will ask you for name or ticket. They will go to office (LoRaWAN server) to check are you invited and is your ticket valid. If ticket is valid, they will give you new permission ticket (Join accept) which will allow you to go and come back whenever you want (Uplinks). If you ask them for some help, they will answer you if they heard you (Downlink).

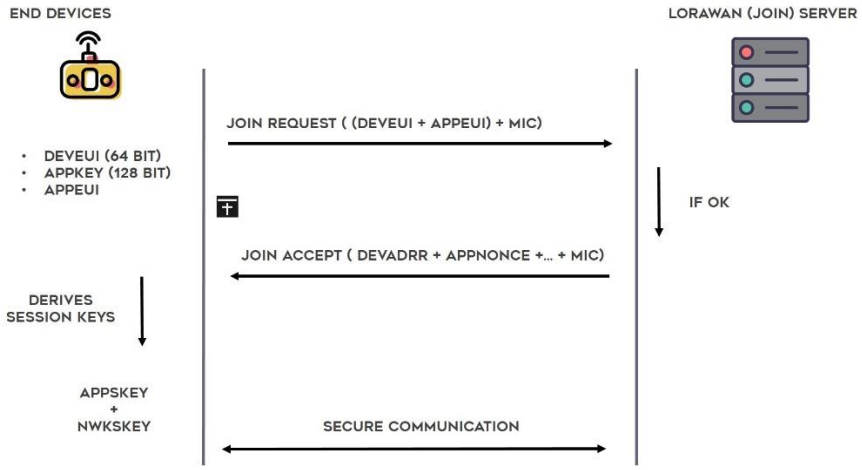


Figure 2 Join procedure

Uplink – transmission from end nodes to upper level (gateways) is named uplink. That are all messages from sensor devices to gateways. In LoRaWAN when end node sends message, all gateways in range will receive message.

Downlink – transmission from gateways to end nodes is named downlink. That are all messages from gateways to sensor devices like confirmation messages or some command messages.

Collision – if 2 end nodes transmit RF packets at the same time, at same frequency and same SF collision can happen. In that case, gateway (hotspot) will be able to receive packet just from 1 end node, and packet from another end node will be thrown away. Packet with stronger signal will "win".

Gateway (hotspot) – hardware device which job is to communicate with end nodes over LoRa communication and with LoRaWAN server over Internet connection. When end device sends message, gateways in range will receive it and forward to LoRaWAN server which will decide what to do with that message (send it to user's console or throw it away). If LoRaWAN server decides that gateway need to respond to end node or send just confirmation message, gateway will send that message over LoRaWAN.

Main point of gateways is to provide coverage at some area and to provide connection to end nodes. With bigger antenna, gateways will be able to receive

LoRaWAN message from end nodes that are farther. Bigger antenna enables them to become more sensitive to weaker signals and read it correctly.

In **Helium** gateways are named hotspots and they have one additional feature – to earn money by creating coverage and network connection. If one gateway/hotspot is installed to one area, it gives value to that area because some sensor device will be able to transfer information over Helium network. For providing that value they are paid.

To ensure gateways/hotspots are providing real coverage Helium integrated Proof-of-Coverage (PoC) protocol which tests are hotspots at real position and are they covering some asked parameters. If these parameters are not fulfilled, gateway will not be paid because it doesn't provide real coverage.

End nodes (sensor devices) – these are hardware devices which generate some information and transmit them over LoRaWAN network. End nodes are often devices that have some sensors which generate data (monitoring eg. temperature, humidity, air quality, light, water, gas, movement, fire).

LoRaWAN enables that these sensors can be battery powered up to 10 year and they can communicate at long distances. That makes them perfect for conditions where there is not external power supply or wire communication.

Duty cycle - The duty cycle of radio devices is often regulated by government. If this is the case, the duty cycle is commonly set to 1%, but make sure to check the regulations of your local government to be sure.

In Europe, duty cycles are regulated by section 7.2.3 of the ETSI EN300.220 standard. This standard defines the following sub-bands and their duty cycles:

g (863.0 – 868.0 MHz): 1%

g1 (868.0 – 868.6 MHz): 1%

g2 (868.7 – 869.2 MHz): 0.1%

g3 (869.4 – 869.65 MHz): 10%

g4 (869.7 – 870.0 MHz): 1%

Additionally, the LoRaWAN specification dictates duty cycles for the join frequencies,the frequencies devices of all LoRaWAN-compliant networks use for over-the-air activations (OTAA) of devices. In most regions this duty cycle is set to 1%.

For US there are no duty cycle regulations.

Frequency (Freq.) – in LoRaWAN it is physical parameter of communication – on that frequency messages are transmitted through air between end nodes and gateways.

Spreading factor (SF) – it affects LoRa modulation. SF7 is lowest SF and it gives you fastest transmission, but lowest range. While SF12 in EU/AU (SF10 in US) allows the longest range, but slow speed of transmission (and higher battery usage). The larger the spreading factor used, the farther the signal will be able to travel and still be received without errors by the RF receiver. Technically it is number of bits per symbol.

Spreading factors for uplinks per area:

EU868: SF7BW125 to SF12BW125

US915: SF7BW125 to SF10BW125 and SF8BW500

AU915: SF7BW125 to SF12BW125

AS923: SF7BW125 to SF12BW125 and SF7BW250

Bandwidth (BW) - difference between the upper and lower frequencies occupied by the chirp: 125 kHz, 250 kHz, 500 kHz.

Counter – number of messages sent from activation. When device starts transmission first time, counter is set to 0. When each next message is sent, counter is increased by 1. This parameter is sent inside of message, and it used to protect message integrity.

Received signal strength indication (RSSI) – the received signal power in milliwatts and is measured in dBm. This is value how receiver “hear” how strong signal is. Values are in most cases between -50dBm (stronger) and -140dBm (weaker). If it is too weak, it is not good because LoRa device than can’t hear message well, which lead to lost messages. Higher RSSI is better in LoRaWAN communication (stronger signal).

Signal to noise ratio (SNR) – this is number which gives indication on the ambient noise level. Noise can be generated by other devices (not just LoRa devices, but other also), from some reflections and many other.

3. Manage GLAMOS Walker

You are able to manage device through menu.

1. **SEND – ONCE** – allows you to send one message on defined SF.
   If you are using OTAA, after turning on device, you will need to Join network first. For Join process, you don't need to choose SF because device will choose that itself.
   1.1. WiFi turned OFF
      1.1.1. If you are sending "CONFIRMED" messages you will see RSSI and SNR of received confirmation
      1.1.2. If you are sending "UNCONFIRMED" messages you will see message "SENT" when sending is done
   1.2. WiFi turned ON
      1.2.1. If you are integrated to GLAMOS server with HTTP POST integration you will get list of gateways (hotspots) that received message together with RSSI and SNR from signal they received (if any gateway received message)
      1.2.2. If you are not integrated to GLAMOS server you will get message "No messages :(" same as when gateway don't receive message

2. **SEND – MULTI** – allows you to send multi messages for fast testing
   2.1. ALL SFs – fast testing on all SFs. "ok" – received confirmation, "x" – no confirmation, "?" – you didn't ask for confirmation from server
   2.2. ODD SFs - fast testing on odd SFs (SF7, SF9, SF11). "ok" – received confirmation, "x" – no confirmation, "?" – you didn't ask for confirmation from server
   2.3. EVEN SFs - fast testing on even SFs (SF8, SF10, SF12). "ok" – received confirmation, "x" – no confirmation, "?" – you didn't ask for confirmation from server
   2.4. SAME SF (loop) – send few messages in a row. This option allows you to send messages in a row. If you are sending CONFIRMED messages, you will get average RSSI of confirmed messages on screen.
   2.5. SAME SF (period) – send with delay between messages. Great for testing in car or while walking. Similar to GPS tracker
3. **PER** – Packet Efficiency Rate – will tell you how successful was testing for each SF

4. **GPS** – when GPS position is locked you will see coordinates
5. **SETTINGS** – change settings for device like WiFi and GPS
   5.1. WiFi – turn ON or OFF WiFi and connect to saved credentials
   5.2. SET NEW WiFi – run config portal for setting up new WiFi credentials. You need phone/computer for this process. Walker will create WiFi Access Point GLAMOS_AP on which you need to connect with phone. It will run config portal automaticaly on your phone. If that doesn't happen, on screen of Walker you can see IP address that you can enter in browser of phone/computer. In most cases that is 192.168.4.1

        In config portal you can choose SSID from list and type in password. Or you can manualy type SSID and password which will be stored.

   5.3. GPS – turn ON or OFF getting GPS data
   5.4. KEYS – read device keys – needed for both OTAA and ABP activation
   5.5. VERSION – firmware (software) and hardware versions listed
6. **PARAMETERS** – change LoRa specific parameters
   6.1. ACTIVATION – allows you to set up activation option (ABP or OTAA)
        - ABP - you can send message right after turning on device if your server allows ABP
        - OTAA – on first sending of message device will join to server (Helium allows just OTAA)

          NOTE: If default is ABP you will need to set OTAA once every time after turning on device through this menu

   6.2. PAYLOAD DECODER – you can see from which parameters is message consisted
   6.3. CONFIRMED/UNCONFIRMED – parameter that tells Walker will it ask confirmation of message receipt from gateway(hotspot)
   6.4. No. CHANNEL – send on 1 specific frequency or on all available frequencies
   6.5. RX2 – determines SF on which device will work in RX2 window
   6.6. PAYLOAD SIZE – determines size of payload that you are sending
   6.7. ANTENNA – allows you to set up which antenna did you attached on Walker. This parameter will be sent in your payload.
   6.8. TX Power – output signal power before antenna
   6.9. POSITION – parameter which will be sent in payload. It can help to analyze locations later.

4. GLAMOS Walk App

4.1. Register on GLAMOS Walk App - VIDEO TUTORIAL

1. Register on https://app.glamos.eu
2. Follow steps in video tutorial for setting up application:
   https://youtu.be/KNUkJyHfcTE
3. Congratulation! You've set up Walk App!
   To start using device, you MUST add it to Helium Console or some other LoRaWAN server.
   If device has GPS connection (blue light above screen or icon in top right corner of screen) and if you send message to your gateway, you will be able to see it in map. In Table you will be able to see all measuring point no matter if you added gateway or not.
   Enjoy! 😊

4.2. Start using Walk App

More info about app and features on:

https://glamos.eu/walkapp

5. Adding Walker to Helium and integration of GLAMOS Walk App

Follow video tutorial

https://youtu.be/pwa3mXbS3x8

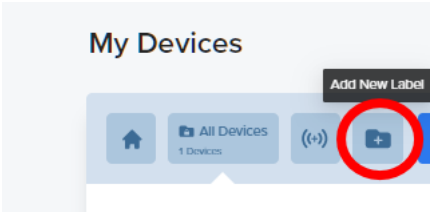
OR

follow next steps:

LABELS

Label is like folder which includes all devices.

1. Go to https://console.helium.com/devices
2. Click “Add New Label” icon at top

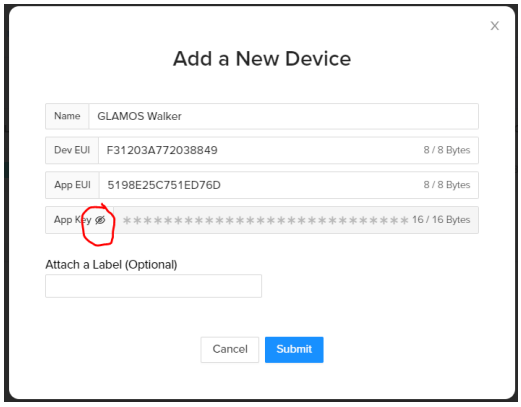


3. Fill in Label name “GLAMOS label” and click “Save label”

ADD DEVICE

NOTE: Without adding device to Helium Console (or some other LoRaWAN server) you will not be able to use device (you will not be able to exchange messages).

1. Go to https://console.helium.com/devices and click “Add new device” icon – left of “Add new label icon”
2. There will be window where you need to type in Name, Dev EUI, App EUI, App Key (make sure to click on small eye near App Key so you can edit it)



3. In Attach a Label" box type name of label you added in steps before. In our example "GLAMOS Label". After few first letter, it will offer to click on it.
4. Click "Submit".

INTEGRATIONS

Messages are sent from device through hotspot to Helium Console. If you don't want to lose all your data, you need to forward them to some service which will store these data.

Here is example how to forward it to GLAMOS Walk App, store it and then visualize and analyze there.

Follow next steps:

5. Go to https://console.helium.com/integrations
6. Under "Add a Custom Integration" choose "HTTP"
7. Fill in these data

   HTTP POST integration:

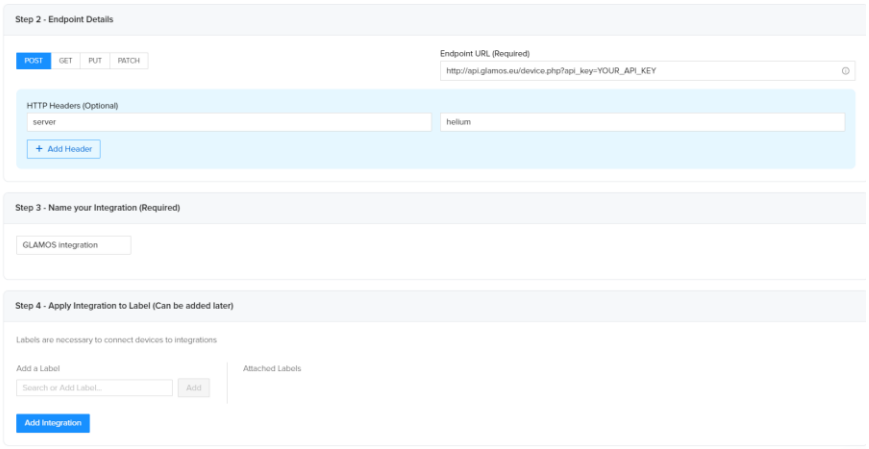
   http://api.glamos.eu/device.php?api_key=YOUR_API_KEY

   NOTE: You need to change "YOUR_API_KEY" with key you can find in Glamos Walk App. You can find API key and whole URL in Account https://glamos.eu/account

   Under "HTTP Headers" fill:

   Header key: **server**

   Heade value: **helium**



8. On "Step 3" fill integration name "GLAMOS integration"
9. On "Step 4" click "Add Integration". (Leave "Add label" box empty)

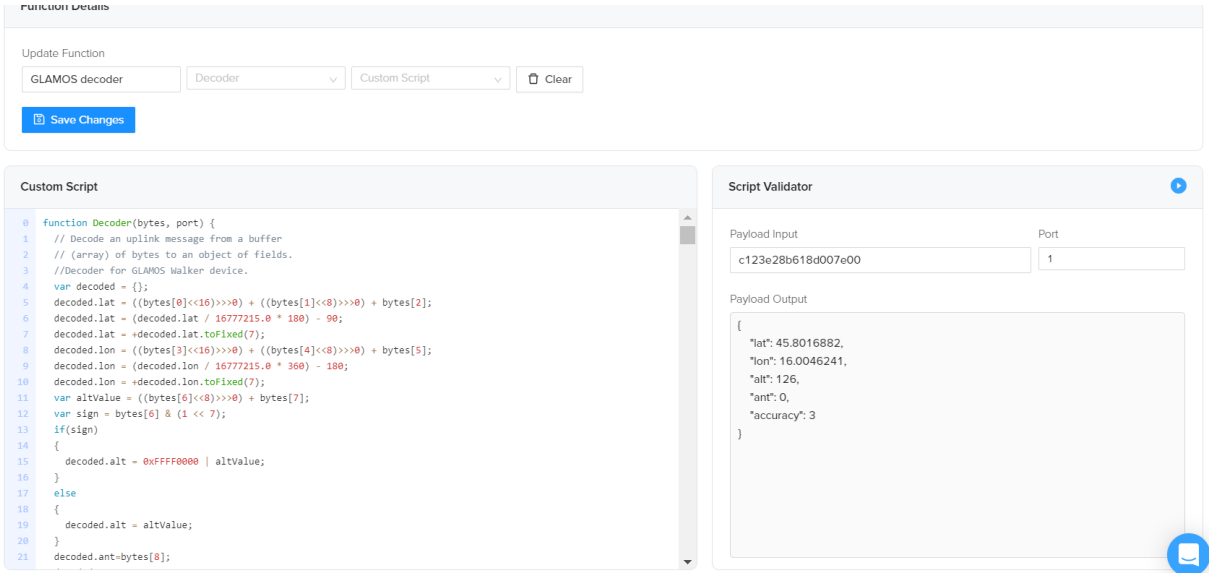
FUNCTIONS

When message arrive to Helium server it is shaped as row of bytes (symbols). We need to parse it in proper way to get our information. Payload decoder is function which is able to decode data and transfer it in shape which is understandable to us.

10. Now go to https://console.helium.com/functions
11. Click “Add function”
12. Now there is “Step 1 - Enter Function Details”. Fill name of function “GLAMOS decoder”, in second column choose “Decoder” and in third column choose “Custom script”. Paste code from this URL: https://glamos.eu/decoder.js

13. There is box “Script Validator”. In “Payload Input” paste **c123e28b618d007e0005** and click on rounded blue “play” icon in top right. You should get “Payload Output”:

```
{
   "lat": 45.8016882,
   "lon": 16.0046241,
   "alt": 126,
   "ant": 0,
   "accuracy": 3
   "position_num": 5
}
```

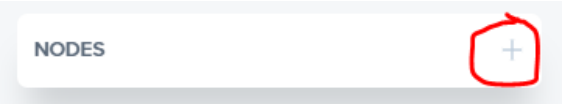


14. Click “Save changes”

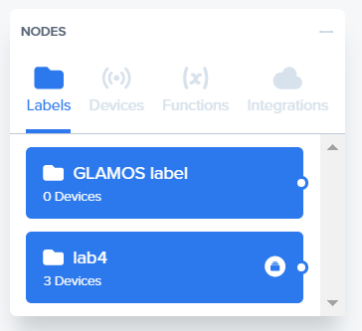
FLOWS

One last step is to create Flow. This is part of application which connects device, payload decoder and integration.

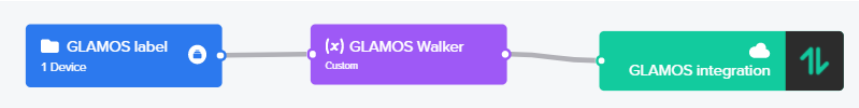
15. Go to https://console.helium.com/flows
16. Click on “+” sign right of “Nodes” text



17. Now click on Labels, and then drag and drop label you created.



18. Repeat same process for Functions and Integration.
19. Finally connect points between Label and Function, and then between Function and Integration.



20. Don’t forget to click “Save changes” at bottom left corner.
21. **Congratulation! You have successfully added GLAMOS Walker to Helium network and integrated it to GLAMOS Walk App!**

ADDITIONAL INTEGRATIONS (optional)

HELIUM MAPPERS (OPTIONAL)

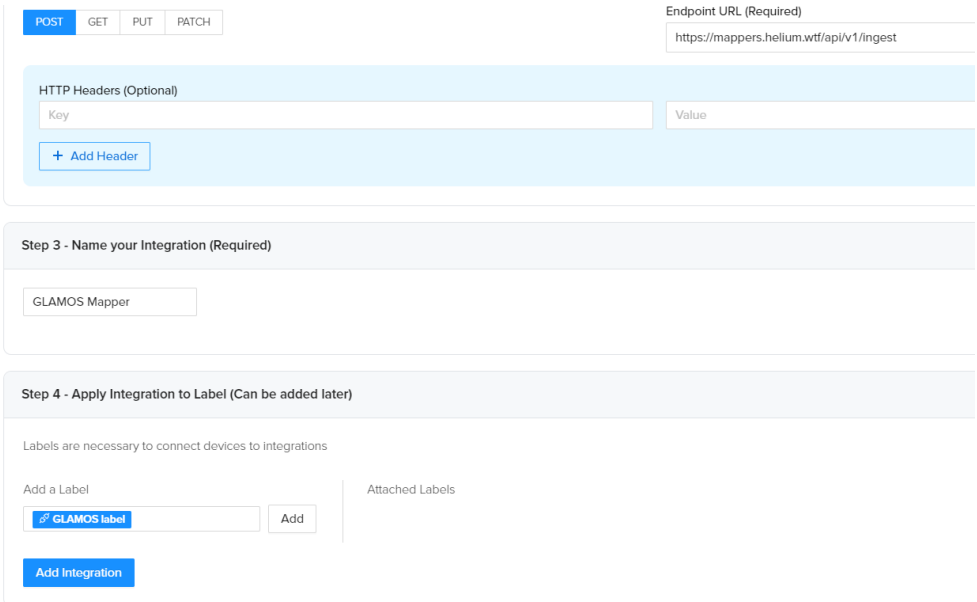
Helium Mapper is community project which goal is to create coverage map of Helium network. All data that are sent to Helium Mapper will be open and public for everyone. You and everyone else will be able to see it at https://mappers.helium.com/

This is OPTIONAL and you can make it if you feel comfortable with sharing your testing and mapping.

1. If you want to **integrate Walker to Helium Mappers** go to https://console.helium.com/integrations
2. Under “Add a Custom Integration” choose “HTTP”
3. Fill in these data

   HTTP POST integration: https://mappers.helium.com/api/v1/ingest/uplink

   Integration name: GLAMOS Mapper
4. On step 3 like in the picture type name. On Step 4 type “GLAMOS label” and there will be label we integrated in our step 15. Click on that label and then “Add Integration”



5. That’s it! Your data will be sent to Helium Mapper also!

6. START TESTING

After successful adding of device and integration of Glamos Walk App you can start enjoying GLAMOS Walker!

Take your device and send a message. You should be able to see it in Helium console.

Now turn on WiFi on Walker (SETTINGS – WIFI – ON). If it is successfully connected (icon on top right corner of screen is not crossed) go to SEND – ONCE and send message. If you are in range of gateway/hotspot and you integrated to Walk App, you will be able to see list of gateways in range together with RSSI and SNR.

7. CONTACT SUPPORT

For any questions and help feel free to send email on:

slaven@glamos.eu

Thank you for choosing **GLAMOS**! Have a great experience!

This document “GLAMOS – Instructions for use (rev5)” was last time edited September, 4th 2021.