

Evaluation of LoRa and LoRaWAN with the Arduino boards and gateway

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Lab of IoT 2024/25

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- ▶ *Historically*, the Internet of Things (IoT) has been a fragmented market with a variety of technologies and standards.

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- ▶ *Historically*, the Internet of Things (IoT) has been a fragmented market with a variety of technologies and standards.
- ▶ There are many protocols for IoT, but the most popular are Zigbee, Z-Wave, Bluetooth, Wi-Fi, and LoRaWAN.

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- ▶ *Historically*, the Internet of Things (IoT) has been a fragmented market with a variety of technologies and standards.
- ▶ There are many protocols for IoT, but the most popular are Zigbee, Z-Wave, Bluetooth, Wi-Fi, and LoRaWAN.
- ▶ LoRaWAN is a low-power wide-area network (LPWAN) protocol based on the LoRa technology.

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- ▶ LoRa is a proprietary wireless communication technology developed by Semtech.

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- ▶ LoRa is a proprietary wireless communication technology developed by Semtech.
- ▶ It is a long-range, low-power, and low-bitrate technology.

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- ▶ LoRa is a proprietary wireless communication technology developed by Semtech.
- ▶ It is a long-range, low-power, and low-bitrate technology.
- ▶ Data can be transmitted at a longer range compared to technologies like WiFi, Bluetooth or ZigBee.

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- ▶ LoRa is a proprietary wireless communication technology developed by Semtech.
- ▶ It is a long-range, low-power, and low-bitrate technology.
- ▶ Data can be transmitted at a longer range compared to technologies like WiFi, Bluetooth or ZigBee.
- ▶ LoRa uses license-free sub-gigahertz radio frequency bands like 433 MHz, 868 MHz (Europe), 915 MHz (USA), and 923 MHz (Asia).

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- ▶ LoRa is a proprietary wireless communication technology developed by Semtech.
- ▶ It is a long-range, low-power, and low-bitrate technology.
- ▶ Data can be transmitted at a longer range compared to technologies like WiFi, Bluetooth or ZigBee.
- ▶ LoRa uses license-free sub-gigahertz radio frequency bands like 433 MHz, 868 MHz (Europe), 915 MHz (USA), and 923 MHz (Asia).
- ▶ LoRa is ideal for applications that transmit small chunks of data with low bit rates.

LoRa bandwidth vs range

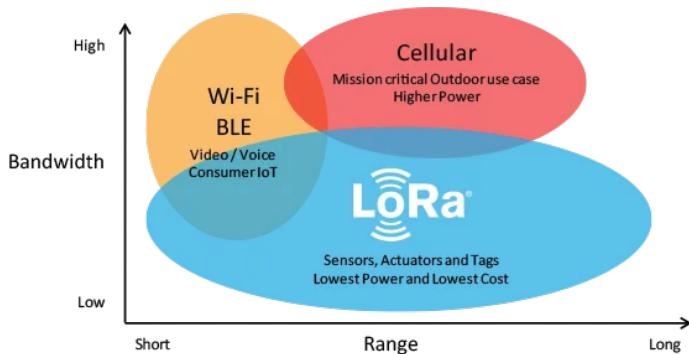


Figure: LoRa bandwidth vs range

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- ▶ LoRaWAN is a Media Access Control (MAC) layer protocol built on top of LoRa modulation.

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- ▶ LoRaWAN is a Media Access Control (MAC) layer protocol built on top of LoRa modulation.
- ▶ It defines device communication and message formats using LoRa hardware.

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- ▶ LoRaWAN is a Media Access Control (MAC) layer protocol built on top of LoRa modulation.
- ▶ It defines device communication and message formats using LoRa hardware.
- ▶ It is designed to support *secure*, bi-directional communication, mobility, and localization services.

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- ▶ LoRaWAN is a Media Access Control (MAC) layer protocol built on top of LoRa modulation.
- ▶ It defines device communication and message formats using LoRa hardware.
- ▶ It is designed to support *secure*, bi-directional communication, mobility, and localization services.
- ▶ LoRaWAN is optimized for low power consumption and supports large networks with millions of devices.

LoRaWAN stack

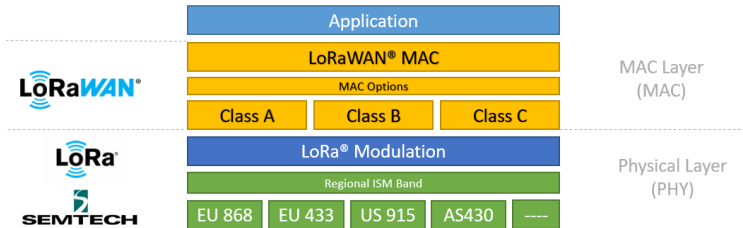


Figure: LoRaWAN protocol stack

LoRaWAN architecture

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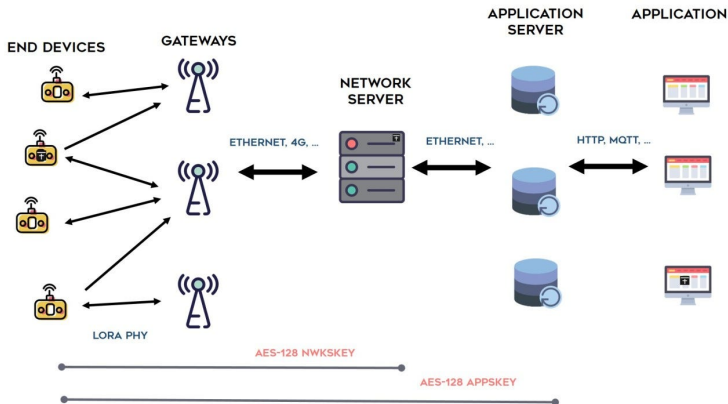


Figure: LoRaWAN architecture

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- ▶ Arduino offers two main boards for the consumers that support LoRa and LoRaWAN: the MKR WAN 1300 and the MKR WAN 1310.

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- ▶ Arduino offers two main boards for the consumers that support LoRa and LoRaWAN: the MKR WAN 1300 and the MKR WAN 1310.
- ▶ Arduino offers two LoRaWAN gateway built by RAKwireless: one for indoor and one for outdoor use.

Boards



Figure: Arduino MKR WAN 1300

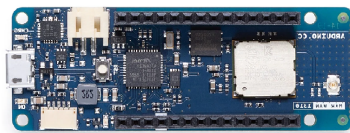


Figure: Arduino MKR WAN 1310

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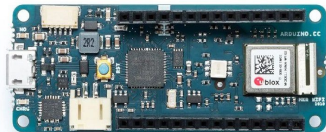


Figure: Arduino MKR WAN 1300

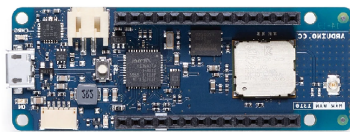


Figure: Arduino MKR WAN 1310

- The 1310 is an upgrade of the 1300.

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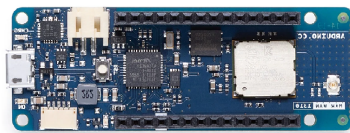


Figure: Arduino MKR WAN 1300 Figure: Arduino MKR WAN 1310

- ▶ The 1310 is an upgrade of the 1300.
- ▶ The main improvement is the energy consumption. The 1300 had a hardware design which resulted in an unnecessary high power consumption.

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Figure: Arduino MKR WAN 1300

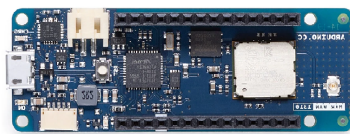


Figure: Arduino MKR WAN 1310

- ▶ The 1310 is an upgrade of the 1300.
- ▶ The main improvement is the energy consumption. The 1300 had a hardware design which resulted in an unnecessary high power consumption.
- ▶ The 1310 now also supports OTA (Over-The-Air) updates and data logging.

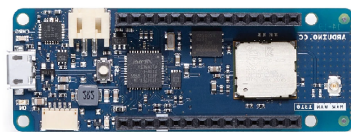


Figure: Arduino MKR WAN 1300 Figure: Arduino MKR WAN 1310

- ▶ The 1310 is an upgrade of the 1300.
- ▶ The main improvement is the energy consumption. The 1300 had a hardware design which resulted in an unnecessary high power consumption.
- ▶ The 1310 now also supports OTA (Over-The-Air) updates and data logging.
- ▶ The price is 50€.

Gateway



Figure: WisGate Edge Lite 2
LoRaWAN indoor gateway



Figure: WisGate Edge PRO
LoRaWAN outdoor gateway

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Figure: WisGate Edge Lite 2
LoRaWAN indoor gateway



Figure: WisGate Edge PRO
LoRaWAN outdoor gateway

- The outdoor gateway is a more professional device.

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Figure: WisGate Edge Lite 2
LoRaWAN indoor gateway



Figure: WisGate Edge PRO
LoRaWAN outdoor gateway

- ▶ The outdoor gateway is a more professional device.
- ▶ The price is 270€ for the indoor and 690€ for the outdoor.

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- ▶ The LoRa technology is easy to use with the Arduino boards.

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- ▶ The LoRa technology is easy to use with the Arduino boards.
- ▶ It is not suitable for applications that require high data rates.

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- ▶ The LoRa technology is easy to use with the Arduino boards.
- ▶ It is not suitable for applications that require high data rates.
- ▶ It is not suitable for applications that require high reliability because there is no acknowledgment mechanism.

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- ▶ The LoRa technology is easy to use with the Arduino boards.
- ▶ It is not suitable for applications that require high data rates.
- ▶ It is not suitable for applications that require high reliability because there is no acknowledgment mechanism.
- ▶ It is not suitable for applications that require high security because the data is not encrypted.

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- ▶ The LoRa technology is easy to use with the Arduino boards.
- ▶ It is not suitable for applications that require high data rates.
- ▶ It is not suitable for applications that require high reliability because there is no acknowledgment mechanism.
- ▶ It is not suitable for applications that require high security because the data is not encrypted.
- ▶ You can build your own protocol on top of LoRa.

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- ▶ A simple implementation of a gossiping protocol on top of LoRa where a node sends a message and the others forward it.

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- ▶ A simple implementation of a gossiping protocol on top of LoRa where a node sends a message and the others forward it.
- ▶ The board with the blue LED sends a message.

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- ▶ A simple implementation of a gossiping protocol on top of LoRa where a node sends a message and the others forward it.
- ▶ The board with the blue LED sends a message.
- ▶ The boards with the white LED forward the message.

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- ▶ A simple implementation of a gossiping protocol on top of LoRa where a node sends a message and the others forward it.
- ▶ The board with the blue LED sends a message.
- ▶ The boards with the white LED forward the message.
- ▶ If the message was already forwarded, the board with the white LED does not forward it again.

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Video of the LoRa gossiping

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- ▶ The LoRaWAN technology is easy to use with the Arduino boards thanks to the *MKRWAN* library. But there is not much documentation and community support.

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- ▶ The LoRaWAN technology is easy to use with the Arduino boards thanks to the *MKRWAN* library. But there is not much documentation and community support.
- ▶ It is suitable for applications that require high reliability because there is an acknowledgment mechanism.

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- ▶ The LoRaWAN technology is easy to use with the Arduino boards thanks to the *MKRWAN* library. But there is not much documentation and community support.
- ▶ It is suitable for applications that require high reliability because there is an acknowledgment mechanism.
- ▶ It is suitable for applications that require high security because the data is encrypted with AES 128.

LoRaWAN Multihop

- ▶ There is no official support for multi-hop or communication between end devices.

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- ▶ There is no official support for multi-hop or communication between end devices.
- ▶ By LoRaWAN specifications, the end devices can only communicate with the gateway.

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- ▶ There is no official support for multi-hop or communication between end devices.
- ▶ By LoRaWAN specifications, the end devices can only communicate with the gateway.
- ▶ To build a multi-hop network, you need to use LoRa. But you will lose the acknowledgment mechanism and the security.

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- The project is to build a LoRaWAN network with the Arduino boards and the gateway.

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- ▶ The project is to build a LoRaWAN network with the Arduino boards and the gateway.
- ▶ The boards will send their sensor data to the gateway.

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Conclusion

- ▶ The project is to build a LoRaWAN network with the Arduino boards and the gateway.
- ▶ The boards will send their sensor data to the gateway.
- ▶ The gateway will send the data to a MQTT broker.

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- ▶ The project is to build a LoRaWAN network with the Arduino boards and the gateway.
- ▶ The boards will send their sensor data to the gateway.
- ▶ The gateway will send the data to a MQTT broker.
- ▶ The data will be extracted from the MQTT broker, decoded from base64, and sent to ThingsBoard and IoT Panels for the visualization. This is done with a GO script.

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- ▶ 3 Arduino MKR WAN 1310 boards.

Figure: LoRaWAN project

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- ▶ 3 Arduino MKR WAN 1310 boards.

a board with a DHT22 sensor to measure the temperature and humidity.

Figure: LoRaWAN project

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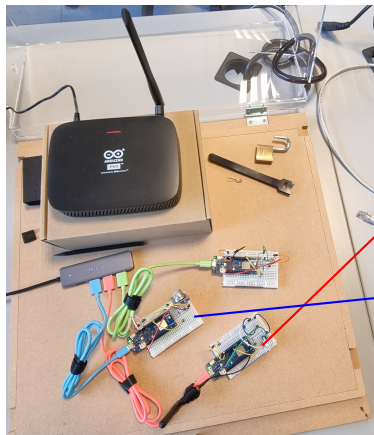
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- ▶ 3 Arduino MKR WAN 1310 boards.

a board with a DHT22 sensor to measure the temperature and humidity.

a board with a MQ-2 sensor to measure the air quality.

Figure: LoRaWAN project

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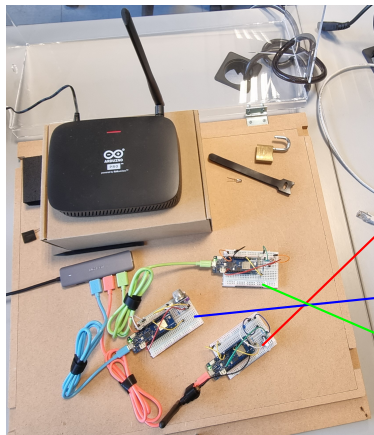


Figure: LoRaWAN project

- ▶ 3 Arduino MKR WAN 1310 boards.
 - ▶ a board with a DHT22 sensor to measure the temperature and humidity.
 - ▶ a board with a MQ-2 sensor to measure the air quality.
 - ▶ a board with a photoresistor to measure the light intensity.

LoRaWAN Project – ThingsBoard



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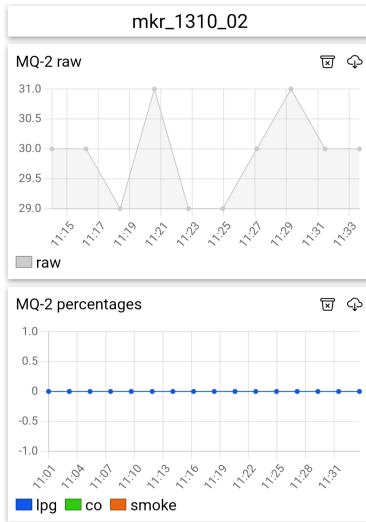
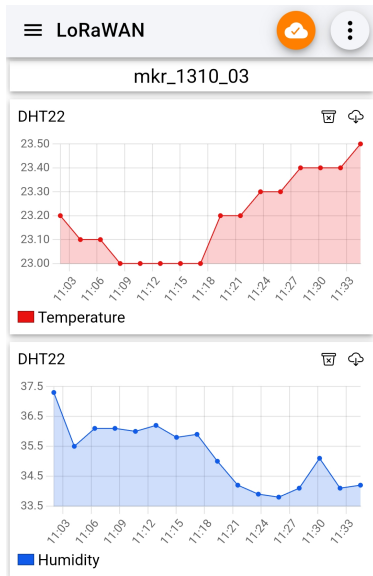
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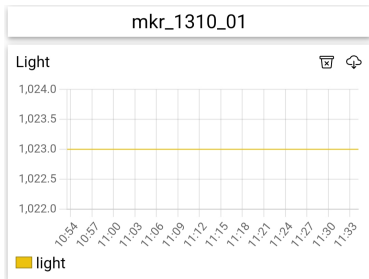
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logs	
logs	 
<code>{"t":23.50,"h":34.20}</code>	application/labiot/device/a8610a343224630f/rx 17-Dec 11:34:31
<code>{"l":1023}</code>	application/labiot/device/a8610a3230497718/rx 17-Dec 11:34:12
<code>{"raw":30,"lpg":0,"co":0,"smoke":0}</code>	application/labiot/device/a8610a3436337816/rx 17-Dec 11:33:39
<code>{"t":23.40,"h":34.10}</code>	application/labiot/device/a8610a343224630f/rx 17-Dec 11:32:21
<code>{"l":1023}</code>	application/labiot/device/a8610a3230497718/rx 17-Dec 11:32:02
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<code>{"t":23.40,"h":35.10}</code>	application/labiot/device/a8610a343224630f/rx 17-Dec 11:30:11
<code>{"l":1023}</code>	

- ▶ The Arduino boards are easy to use with the LoRa and LoRaWAN technologies.

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- ▶ The Arduino boards are easy to use with the LoRa and LoRaWAN technologies.
- ▶ The documentation and community support are not very good because these boards seems not to be widely used. Probably because people prefer to use a LoRa module and a microcontroller separately.

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- ▶ The Arduino boards are easy to use with the LoRa and LoRaWAN technologies.
- ▶ The documentation and community support are not very good because these boards seems not to be widely used. Probably because people prefer to use a LoRa module and a microcontroller separately.
- ▶ The 1300 version has a high power consumption and some software/hardware issues when uploading the sketch.

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- ▶ The Arduino boards are easy to use with the LoRa and LoRaWAN technologies.
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- ▶ The 1300 version has a high power consumption and some software/hardware issues when uploading the sketch.
- ▶ The boards are probably not suitable for professional applications, but they are good for educational purposes or home projects.

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- ▶ The transmission range indoor was not very good. In a university building with concrete walls, the range was about 100 meters.

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- ▶ The transmission range indoor was not very good. In a university building with concrete walls, the range was about 100 meters.
- ▶ You can transmit data to the gateway every 2 minutes. This is enforced by the board firmware and it is not a limitation of the LoRaWAN technology.

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- ▶ The transmission range indoor was not very good. In a university building with concrete walls, the range was about 100 meters.
- ▶ You can transmit data to the gateway every 2 minutes. This is enforced by the board firmware and it is not a limitation of the LoRaWAN technology.
- ▶ You can not use both LoRa and LoRaWAN at the same time because their configuration conflicts.

Gateway

- ▶ The first setup of the gateway is not easy because there are missing informations in the documentation. For example, the gateway needs 10–15 minutes to boot up and this is written nowhere.

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- ▶ The first setup of the gateway is not easy because there are missing informations in the documentation. For example, the gateway needs 10–15 minutes to boot up and this is written nowhere.
- ▶ Updating the firmware may corrupt some settings and you need to set them again. In the UI, it will show as they are set, but they are not.

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- ▶ Updating the firmware may corrupt some settings and you need to set them again. In the UI, it will show as they are set, but they are not.
- ▶ You can only have 1 tab open in the UI. If you open a second tab, the first one will be disconnected. This means multiple users can not use the UI at the same time.

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- ▶ You can only have 1 tab open in the UI. If you open a second tab, the first one will be disconnected. This means multiple users can not use the UI at the same time.
- ▶ You have to go to the RAKwireless documentation to find most of the informations.

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- ▶ The first setup of the gateway is not easy because there are missing informations in the documentation. For example, the gateway needs 10–15 minutes to boot up and this is written nowhere.
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- ▶ You can only have 1 tab open in the UI. If you open a second tab, the first one will be disconnected. This means multiple users can not use the UI at the same time.
- ▶ You have to go to the RAKwireless documentation to find most of the informations.
- ▶ Overall, the main issue is the missing of a detailed documentation by Arduino and RAKwireless. There is also a very poor community support because the gateway is not widely used.

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- ▶ LoRa and LoRaWAN are good technologies for IoT applications that require low power consumption and long-range communication.

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- ▶ LoRa and LoRaWAN are good technologies for IoT applications that require low power consumption and long-range communication.
- ▶ The Arduino boards are easy to use with the LoRa and LoRaWAN technologies, but the documentation and community support are not very good.

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- ▶ LoRa and LoRaWAN are good technologies for IoT applications that require low power consumption and long-range communication.
- ▶ The Arduino boards are easy to use with the LoRa and LoRaWAN technologies, but the documentation and community support are not very good.
- ▶ The Arduino boards are probably not suitable for professional applications, but they are good for educational purposes or home projects.

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- ▶ LoRa and LoRaWAN are good technologies for IoT applications that require low power consumption and long-range communication.
- ▶ The Arduino boards are easy to use with the LoRa and LoRaWAN technologies, but the documentation and community support are not very good.
- ▶ The Arduino boards are probably not suitable for professional applications, but they are good for educational purposes or home projects.
- ▶ The gateway is not easy to set up because of the missing informations in the documentation and the poor community support.

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- ▶ LoRa and LoRaWAN are good technologies for IoT applications that require low power consumption and long-range communication.
- ▶ The Arduino boards are easy to use with the LoRa and LoRaWAN technologies, but the documentation and community support are not very good.
- ▶ The Arduino boards are probably not suitable for professional applications, but they are good for educational purposes or home projects.
- ▶ The gateway is not easy to set up because of the missing informations in the documentation and the poor community support.
- ▶ The tested transmission range indoor was not very good.

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