T-MOBILE NB-IOT PACKAGE TRACKER

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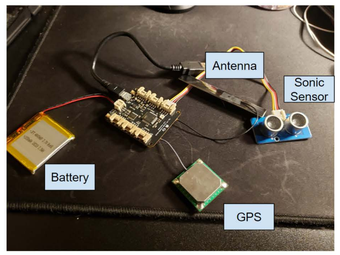
NB-IoT

- Narrowband-Internet of Things (NB-IoT) is a modern network radio technology that focus specifically:
  - Wide coverage.
  - High connection density.
  - Optimized battery life.
  - Low cost.

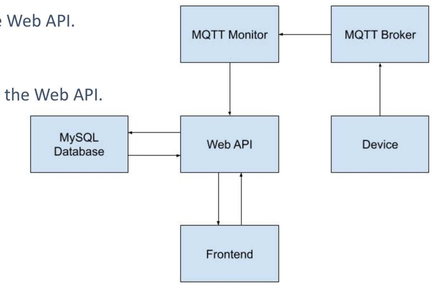
Wio LTE Cat NB-IoT (SARA-N410) Tracker

- Twilio Narrowband board equipped with :
  - T-Mobile Narrowband SIM.
  - U-Blox SARA-N410 Transceiver module.
  - Grove Ultrasonic Ranger V2.0.
  - +1050mAh 3,7V Battery.
  - U-Blox Max-M8Q GNSS modules.
  - LTE-Antenna.



Block Diagram & Feature

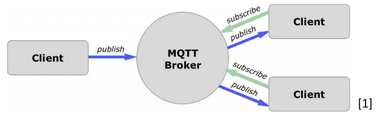
- MQTT Broker will:
  - Receive data from device.
- MQTT Monitor will:
  - Monitor the MQTT Broker.
  - Upon receiving a message, it will send the information to the Web API.
- Web API will:
  - Act like a central hub for all cloud communications.
  - Send data received to the MySQL Database for storage.
- MySQL Database
  - Grab data from the MySQL Database to send to the frontend.
- Frontend will:
  - Display data received from the Web API.
- MySQL Database will:
  - Store any data given to it from the Web API.



MQTT

Why MQTT?

- Lightweight protocol – Fast data transmission.
- Minimized packet size - Low network usage.
- Low power usage – More battery life.



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How MQTT Works?

MQTT Protocol is based on client/server.

- Server is called MQTT broker.
- Client are the IoT devices.
- Topics a place where clients put/retrieve a message to/from.

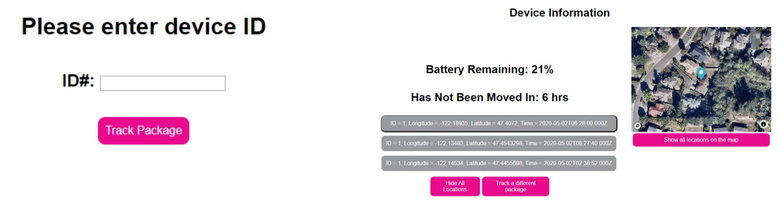
Clients/Server communicate by publishing/subscribing to Topics.

Client send ("publish") to Topic on server. Client retrieve "subscribes" to topic on the server.

Broker (Server) manage publishing/subscribing actions to target topic.

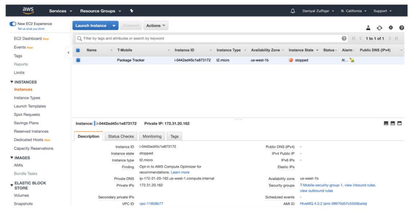
Frontend

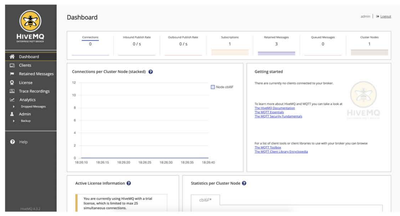
- Using HTML and JavaScript, we constructed a frontend in which the user will be able to find information about their package.
- The frontend calls an API that we constructed which will send the appropriate data from a MySQL database sends it back to the frontend.
- Using the data the frontend received from the API, the frontend displays the data in an informative matter for the user.



Server Side/ Broker HiveMQ

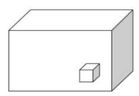
- HiveMQ Broker is used for connecting IoT devices.
- HiveMQ is deployed to AWS EC2 instance with the help of built in Amazon Machine Image (AMIs).
- The image to the bottom left shows an AWS instance.
- The bottom right image shows the HiveMQ control center indicating the HiveMQ broker instance is deployed and running.





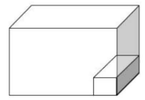
Box design

- Design for holding the IoT device inside the package is needed in order to protect the device from transportation and discovery.



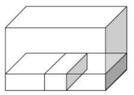
Product itself

- Advantages:
  - Easy to return.
  - Less material.
- Disadvantages:
  - Minimal protection.
  - Prone to shaking.



Removable Box

- Advantages:
  - Ease to return.
- Disadvantages:
  - Not a seamless design.
  - Very noticeable once opened box.

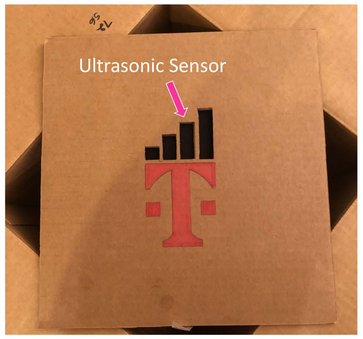


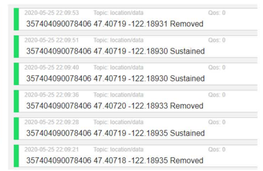
False Bottom

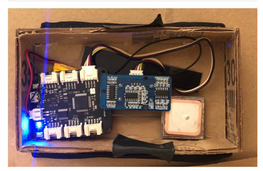
- Advantages:
  - Hard to notice.
  - Safest design out of three.
- Disadvantages:
  - Difficult to return the device.

Result

- The Twilio NB-IoT Device is embedded using a package with a false bottom concept.
- False Bottom helps to conceal the device as it tracks the package while staying out of sight from those who have malicious motives.
- The Ultrasonic Sensor is embedded behind a sheet of acoustic cloth on the third black bar.
- This sensor tracks if an item from the package is removed based on a set distance (30 cm).
- The Twilio Device constantly tracks and monitors the package by sending data through MQTT in the following format: "Device ID, Latitude, Longitude, Package Status".







Future Work, References, and Acknowledgments

- Battery information
- Possible upgrade to ultrasonic sensor
- Movement/Motion notice of the box
- Estimated time of arrival in frontend.
- Geo-Fencing to create geographical boundaries.

References:

[1]A. Mostafa, "MQTT Protocol Complete Tutorial", 1Sheeld, 2020. [Online]. Available: https://1sheeld.com/mqtt-protocol/.

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