The Internet of Things in Drone Network Applications

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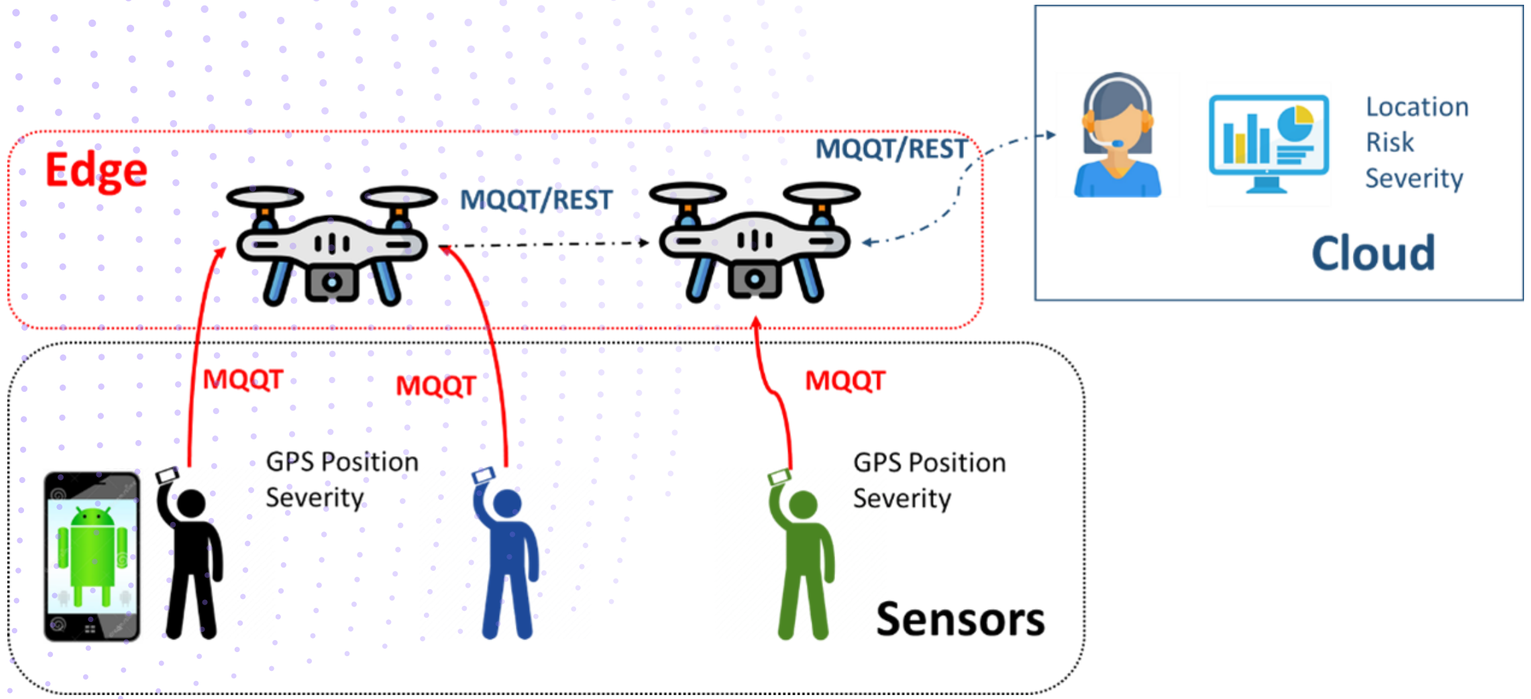
What is the problem?

Disasters are unpredictable natural phenomena which tend to leave frighteningly outrageous consequences, causing people and communities a disturbance on their daily life, as sometimes infrastructure is devastated, telecommunication resources become unavailable and these being restored is expensive and takes a lot of time.

Moreover, the harshness of the disaster is complemented by the fact that some communities are not well prepared to face a disaster, making all the consequences more severe and the recovery process more complicated than it actually is.

Unfortunately, according to several testimonies of survivors to different disasters, a common thing that happens during and after the phenomenon strikes is that it is impossible to reach the emergency lines available to ask for help, due to the telecommunication resources being affected.

In order to help different communities and trying to give a resolution to this problem, we implemented a computer system based on microcontrollers connected to the Internet for the acquisition of data by sensors and the control of actuators in a home automation application. This system is the best way to provide an efficient and secure environment to send a distress message to the rescue teams when a natural disaster occurs.



Bruna Campos

"I consider myself pretty optimistic, but when it comes to natural disasters and flooding, I want to be the best prepared for the worst-case scenario to help others."

Personal Background

Age: 23 years old
Gender: Female
Family Status: Single, three brothers and elder parents.
Education: B.S. in Biotechnology
Location: Petrópolis, Rio de Janeiro
Persona group: User Persona (Victim)

Professional Background

Professional occupation: Biology high school teacher
Income level: 7320 Brazilian reals per month.
Work experience: UN UNDAC volunteer

User environment

Technical devices: phone, iphad, computer.
Workplace: Rio de Janeiro high school
Collaboration: Meetings and reunions with colleague teachers, school directives, students and parents.

End goal

Have access to life-saving tools and resources to help other people.

Scenario

During the rainy season, my work and residence area (Petrópolis, Rio de Janeiro) is prone to hazardous flooding that risks people's and my students' lives; hence, I want to use a tool to help everyone arrive home safely.

Psychographics

User attitudes:

- She feels the responsibility to take care of her students during an emergency.
- She is calm during stressful situations.

Interests:

- Kayaking, hiking, playing beach volleyball.
- Ecosystem preservation.

Motivations:

- Bruna's mission's to help those in need, be it vulnerable people or endangered species.

Pain-Points:

- School protocol for emergencies could be more efficient.
- She couldn't contact emergency services during the last flooding due to power outages.

Rafael Costa

"If there's a chance to help those in need, I will do anything in my power to do so."

Personal Background

Age: 34 years old
Gender: Male
Family Status: Married, two daughters
Education: Firefighter training
Location: Petrópolis, Rio de Janeiro
Persona Group: User Persona (Command and Control firefighter)

Professional Background

Professional occupation: Command and Control Firefighter
Income level: 4,940 Brazilian reals per month.
Work experience: First Aids trainer.

User environment

Technical devices: Application server, computer, operations dashboard, radio, walkie-talkies.
Workplace: Rio de Janeiro Fire department
Collaboration: Colleague firefighters and life-saving services.

End goal

Save endangered lives with the least risk, losses, and resources possible.

Scenario

During the rainy season, my work and residence area (Petrópolis, Rio de Janeiro) is prone to hazardous flooding that risks people's and my team's lives, so, at the Command and Control Unit, I want to better help my team perform.

Psychographics

User attitudes:

- He has a great work ethic.
- He has a very high commitment to his duty.

Interests:

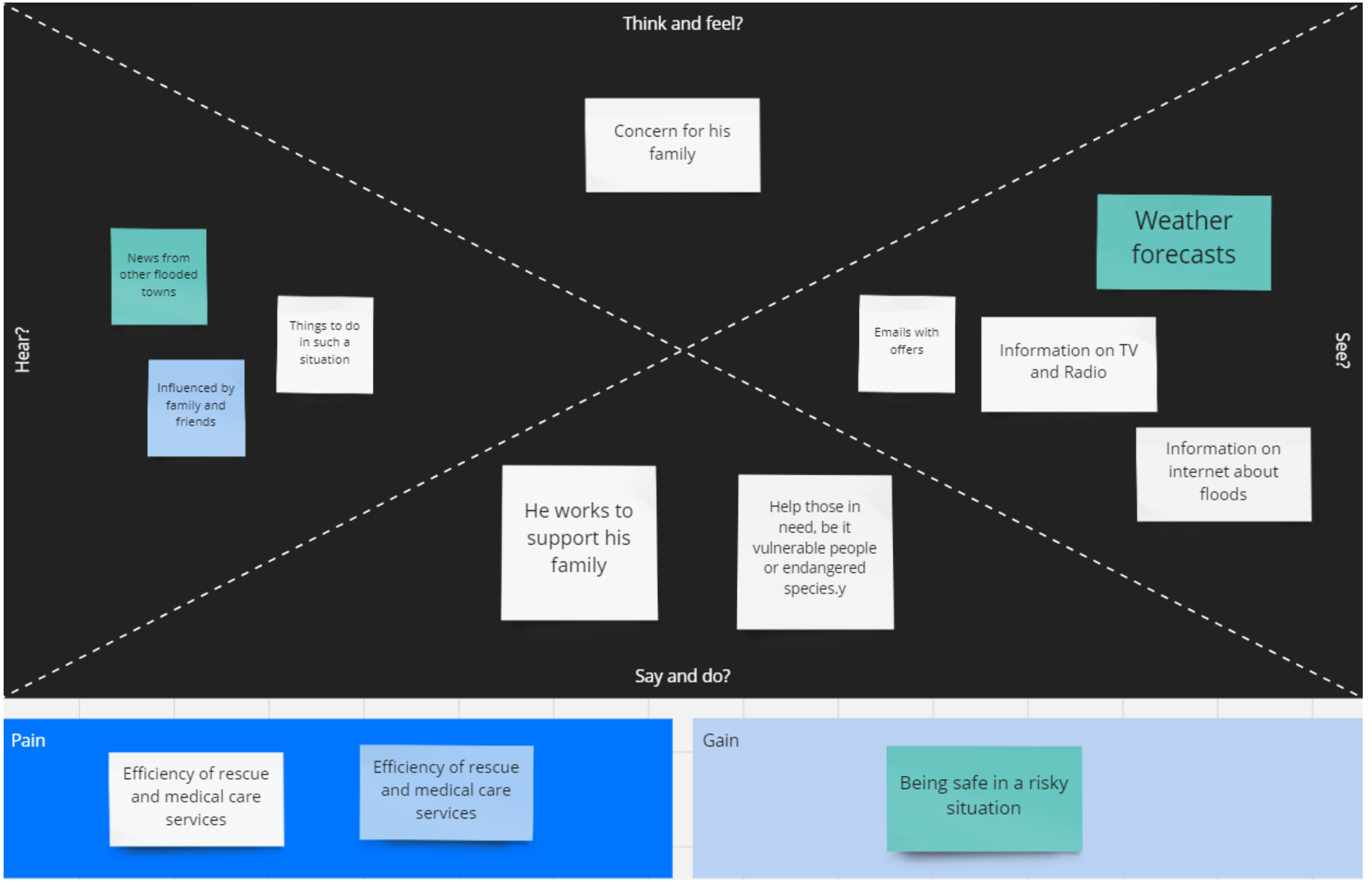
- Playing rugby with his friends.
- In fashion gadgets and videogames.

Motivations

- Rafael wants to save every life he encounters at work.
- He wants to protect his firefighter team.

Pain-Points:

- He is furious about power outages during emergencies.
- Rafael thinks the operative processes in the fire control unit can be optimized to be more efficient.


Think and feel?
Concern for his family
Weather forecasts
News from other flooded towns
Things to do in such a situation
Influenced by family and friends
Emails with offers
Information on TV and Radio
Information on internet about floods
Hear?
See?
He works to support his family
Help those in need, be it vulnerable people or endangered species.y
Say and do?
Pain
Efficiency of rescue and medical care services
Efficiency of rescue and medical care services
Gain
Being safe in a risky situation

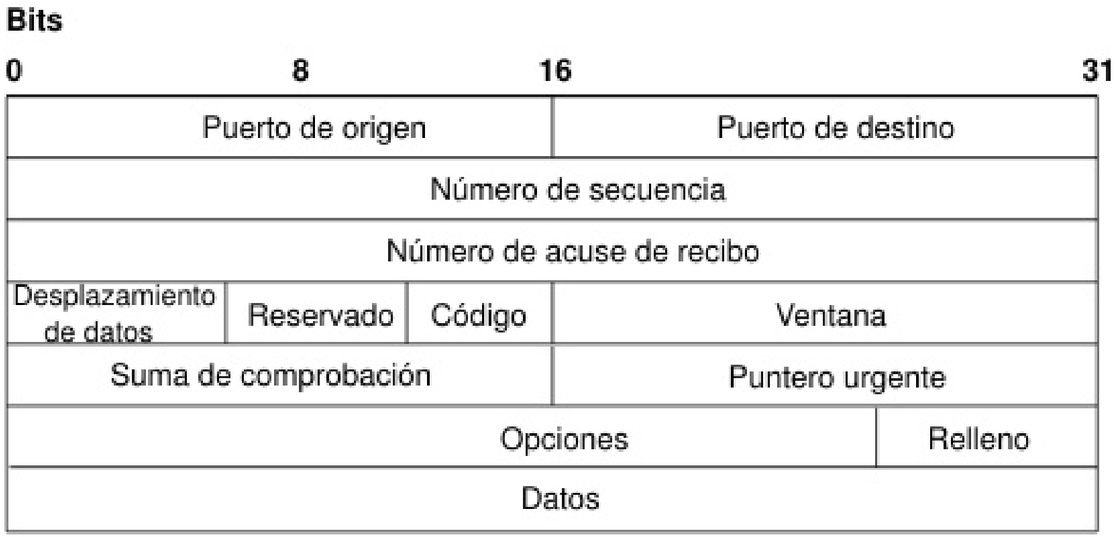
Technical Architecture of the Solution

TCP (Transfer Control Protocol)

TCP is a protocol for transportation of data:

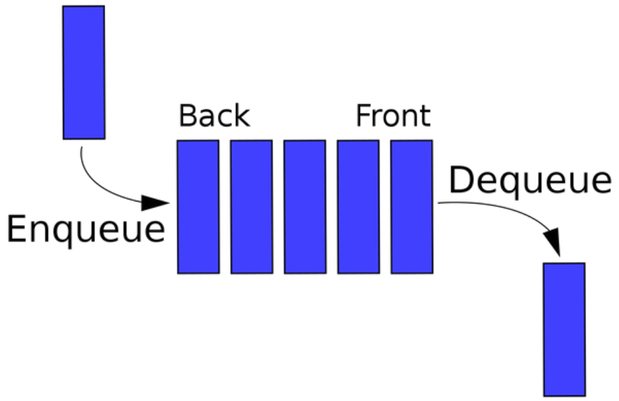
- Establishes a Session
- Ensures Reliable Delivery
- Provides same-order delivery
- Support flow control
- Path setup before data is send
- Data need not have address. The circuit number is sufficient.

This protocol is used in email, web browsing and we are using this for IoT.



Header of all data sended uses the TCP protocol

The MQTT protocol



Message Queue Telemetry Transport (MQTT)

Quality of Service (QoS)

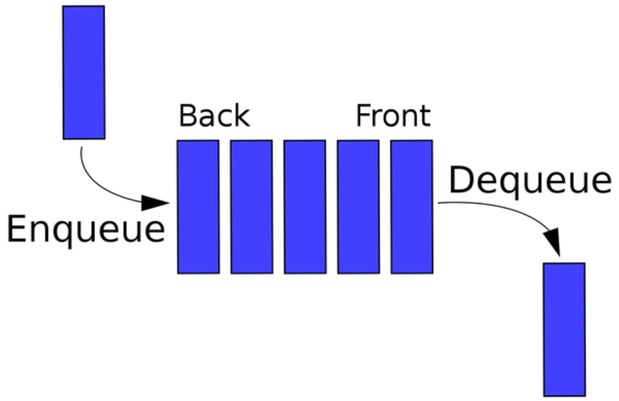
There are many communication protocols used in IoT (Internet of Things) we choose the MQTT. The MQTT (Message Queue Telemetry Transport) protocol is a connection-oriented communications protocol, it is designed for high-latency, low-bandwidth, and unreliable networks. This protocol consumes little power on the device it's running on. We use MQTT with a LoRaWan (Long Range Wide Area Network). The anterior factors make the MQTT protocol ideal for IoT communications.

In this protocol, there are three parts involved which are the **publisher**, the **broker,** and the **subscriber**.

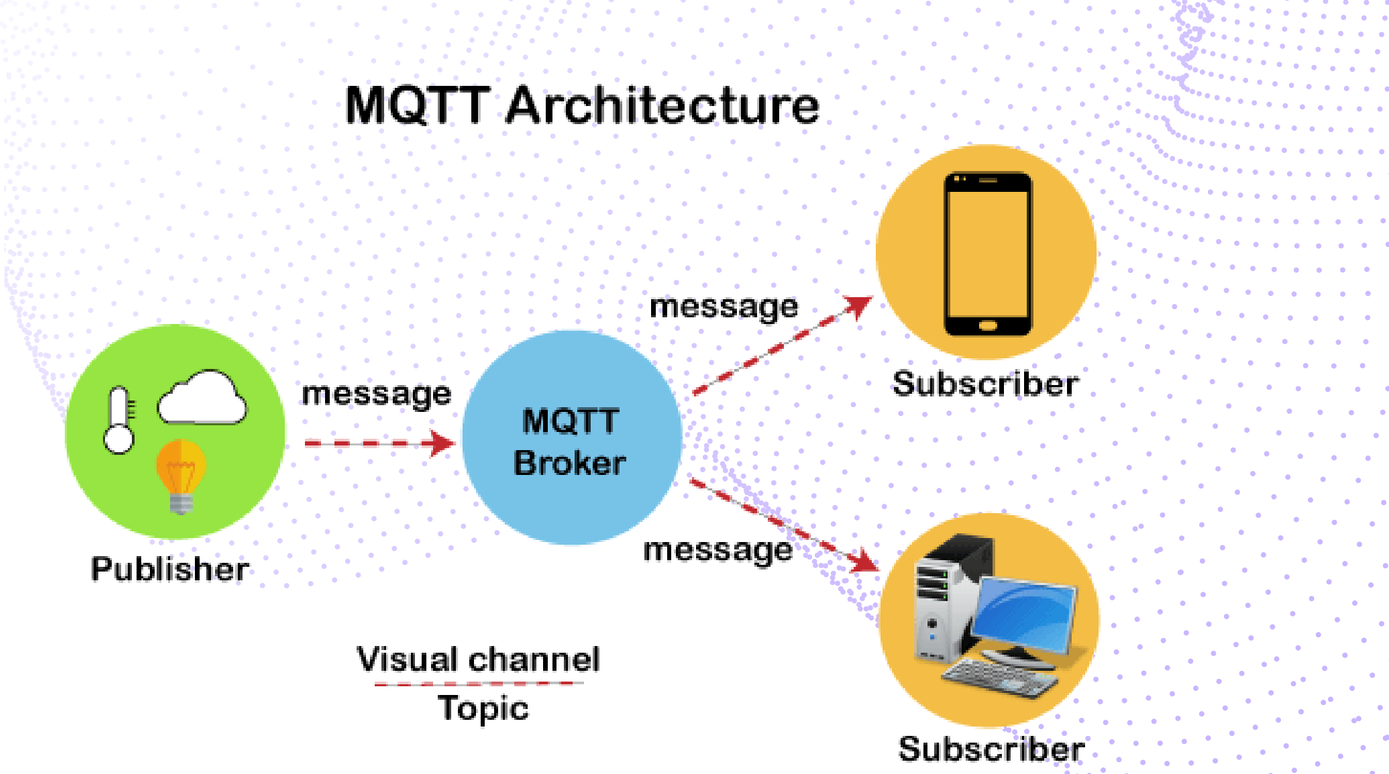
Quality of Service (QoS)

The quality of service is a agreement between the sender and receiver that guarantees the deliverability of a message. There are three qualities of service: the QoS 0, in which there isn't any validation; the QoS 1, which guarantees that the message is delivered at least one time to the receiver; and the QoS 2, which guarantees that each message is received only once by the intended recipients.

The MQTT protocol



Message Queue Telemetry Transport



What does this protocol do?

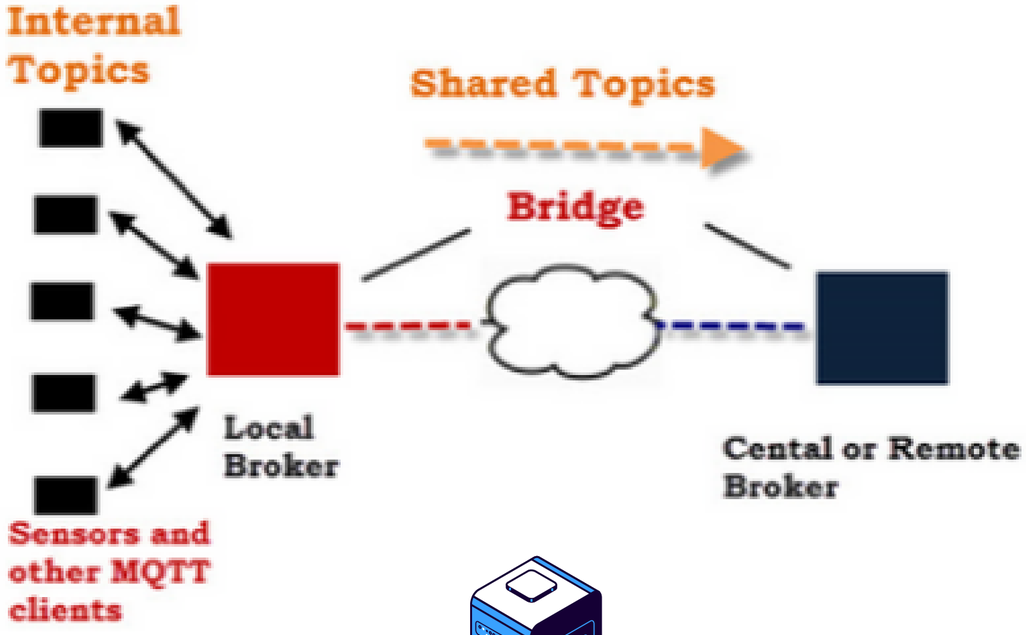
This protocol consists of one publisher sending a message with a specific topic, after the server (broker) stores that message and sends a confirmation message (in quality of service 1 or 2). After that, the server stores the message in a queue depending on its topic, and then, when a subscriber connects to the broker, receives all messages on a specific topic.

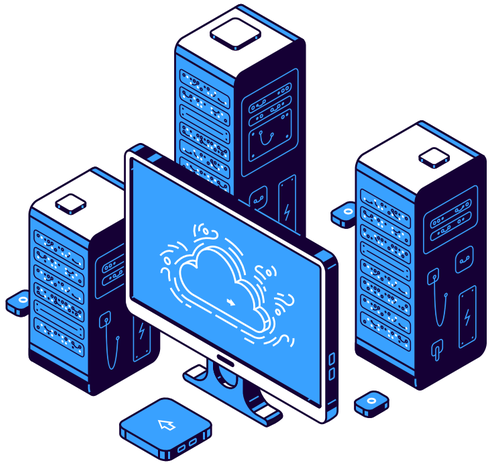
The " Mosquitto" broker was used to provide the server with this protocol. (Running in a Linux Virtual Machine (Ubuntu))

Bridging MQTT Brokers

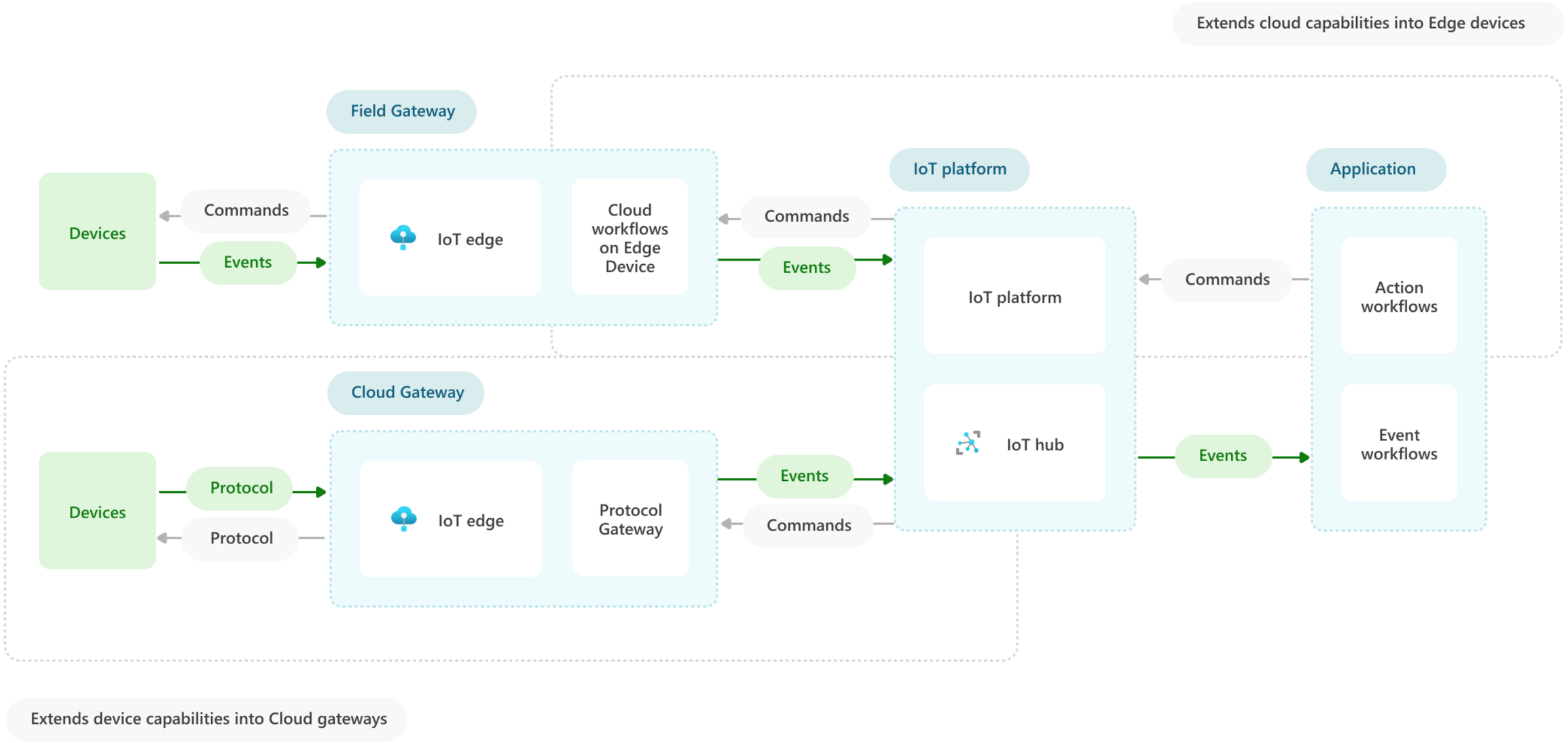
Bridging in MQTT lets you connect two MQTT brokers to share messages between them.

When a broker acts as a bridge, this broker sends all messages that it receives to another broker (it can be another bridge or the central broker). This is mainly implemented for security purposes, for example, if we want authentification in subscribers but not publishers.

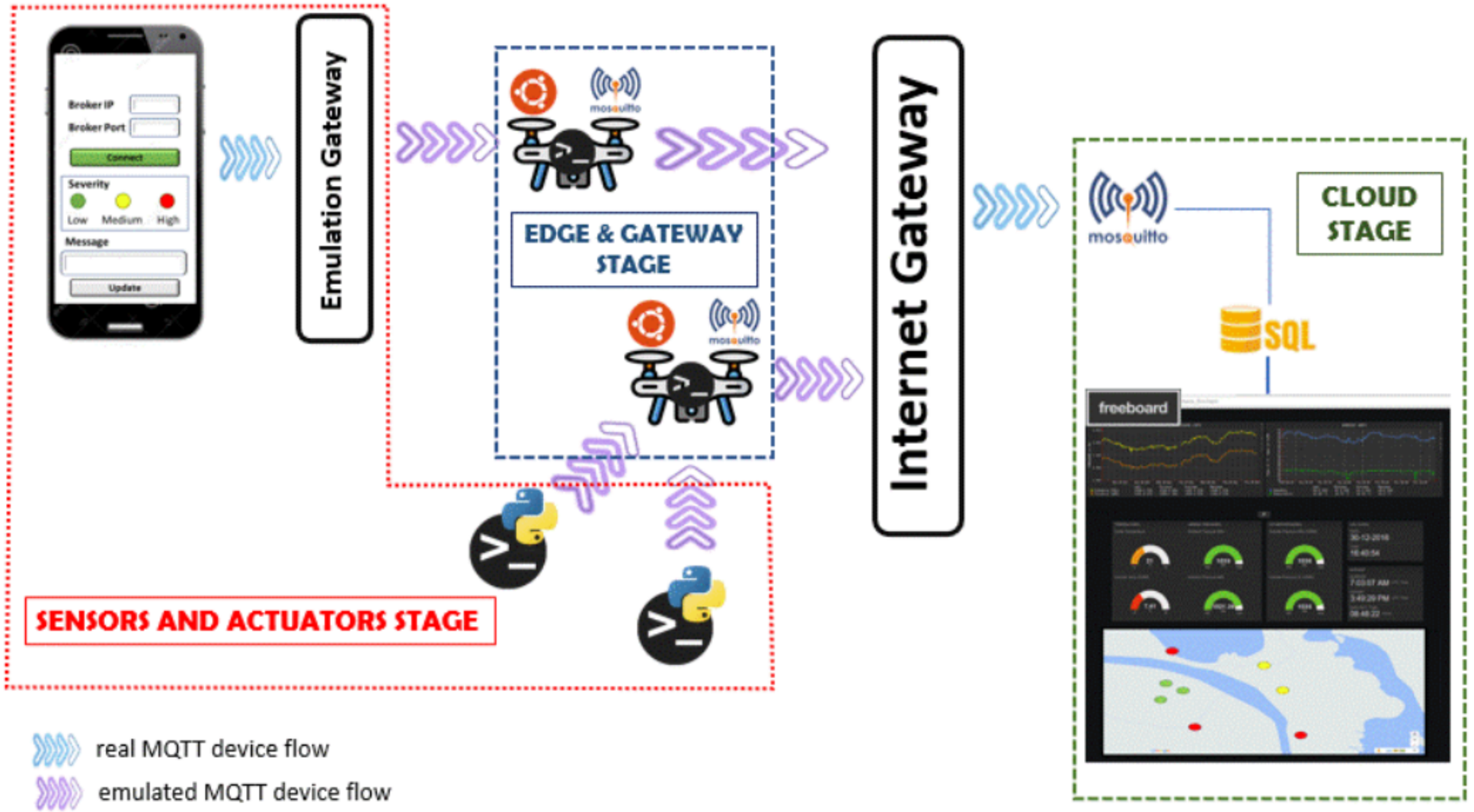




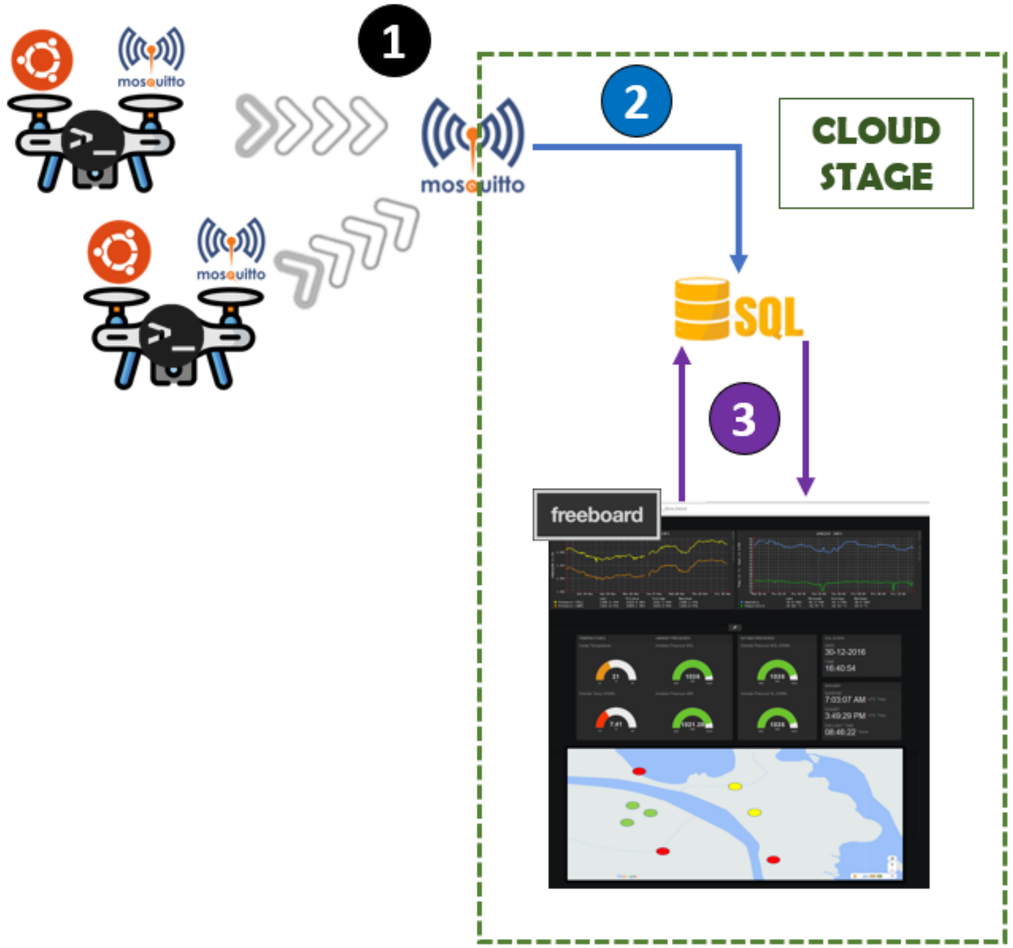
IoT architecture's building blocks of the Solution

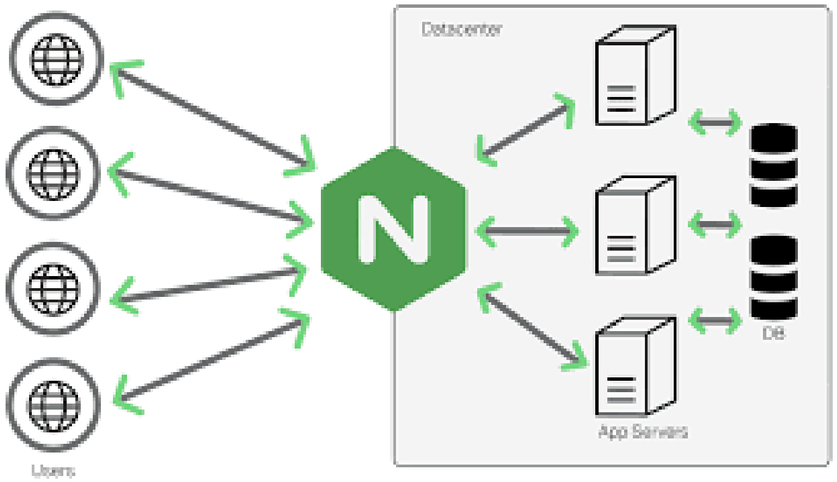


Stage model


Broker IP
Broker Port
Connect
Severity
Low
Medium
High
Message
Update
Emulation Gateway
mosquitto
EDGE & GATEWAY STAGE
mosquitto
SENSORS AND ACTUATORS STAGE
Internet Gateway
mosquitto
CLOUD STAGE
SQL
freeboard
real MQTT device flow
emulated MQTT device flow

Dashboard
Implementation

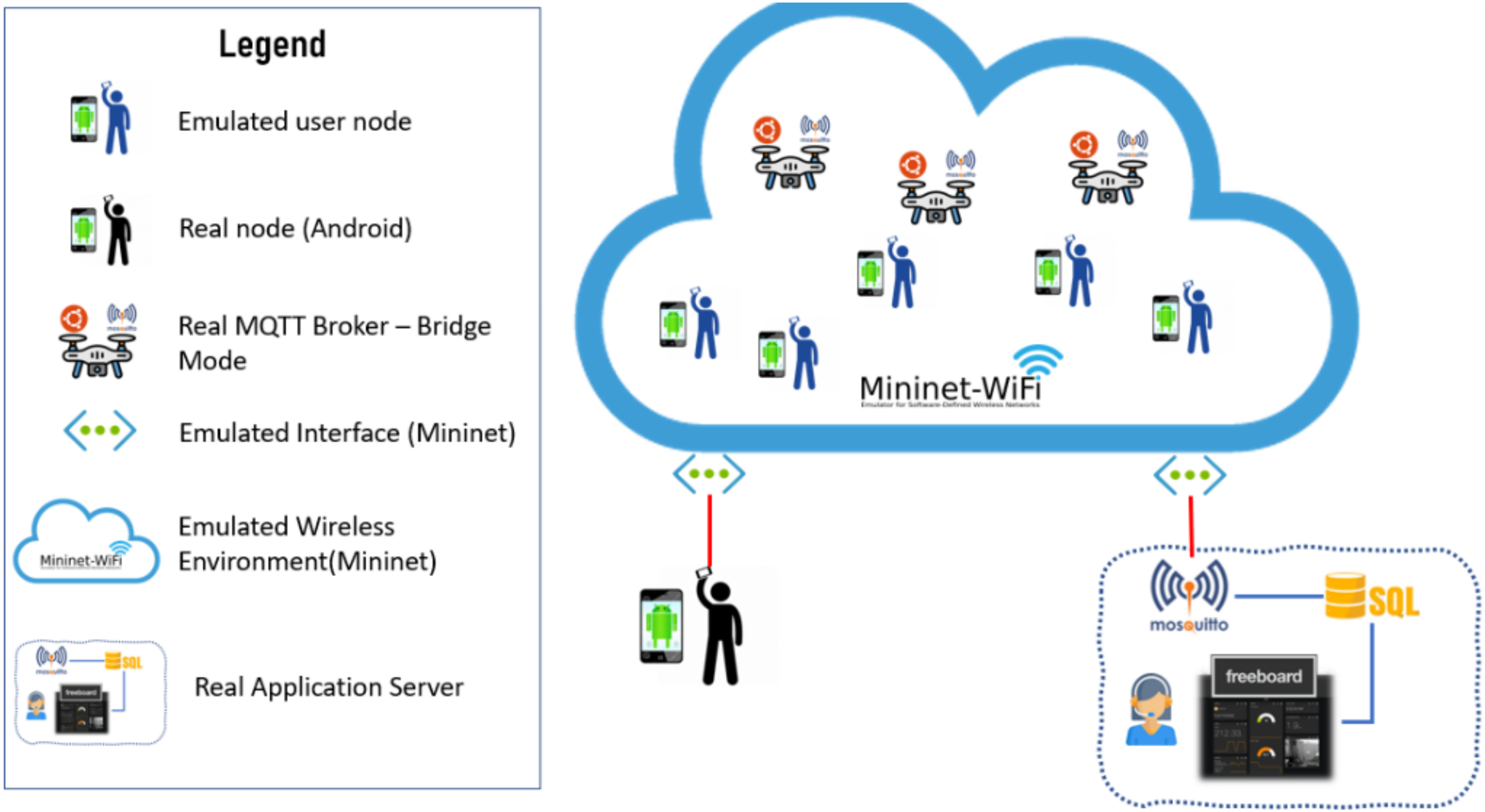




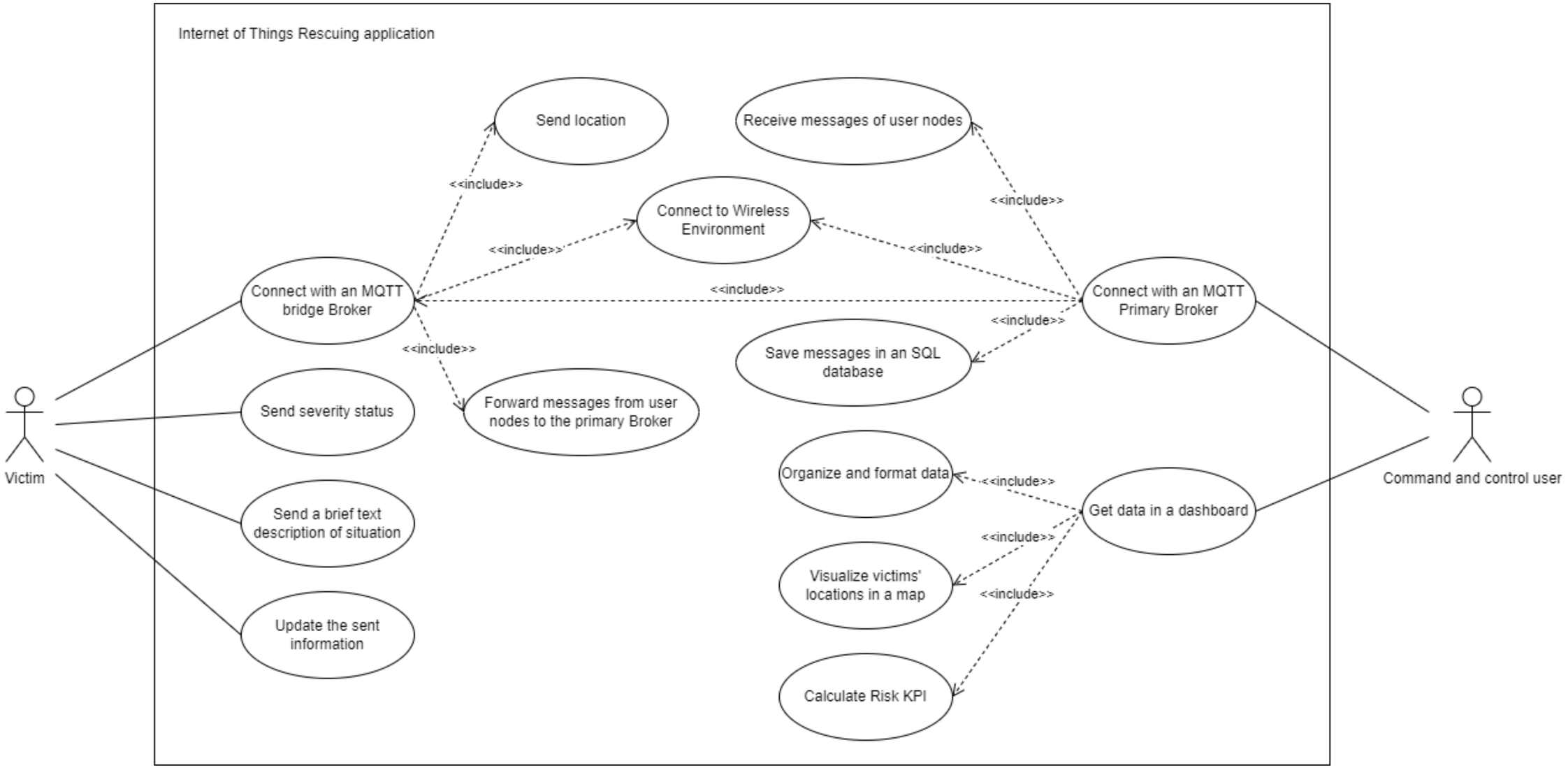
Grafana

MySQL®

A logical view of the solution's technical architecture



UML Use Case Diagram of the Solution



How to configure the solution?

Run solution

Innitiate virtual machine

Run emulator

1. npm install
2. npx react-native start

Run broker, subscriber and dashboard

1. systemctl start grafana
2. systemctl start nginx
3. mosquitto -c mosquittoAPPCB -v
4. mosquito -c mosquittoAPPCB -v
5. python3 sub.py

System Demo

Thank you!

The Internet is not a luxury, it is a necessity.
Barack Obama

References

IBM. (2021). Protocolo de control de transmisiones (Transmission Control Protocol). Recovered from https://www.ibm.com/docs/es/aix/7.1?topic=protocols-transmission-control-protocol

Kabartsjc. (2022). GSL Final Course - ITA & Tecnológico de Monterrey. Recovered from https://github.com/kabartsjc/gsl-iot-2022/blob/main/templates/mosquitto/MOSQUITTO.md

MQTT. (2022). MQTT: The Standard for IoT Messaging. Recovered from https://mqtt.org