- Date: 07-05-2024
- Instruction Resource for Beginners

Material to Grasp the Available IoT System

- The university thesis illustrating the system:
  - ThesisVersioning0_1_0/Thesis-Template0_1_0/main.pdf at main · ngminhthanh12a3/ThesisVersioning0_1_0 (github.com)
  - ThesisVersioning0_1_0/Presentation/ThesisPresentation/slides.pdf at main · ngminhthanh12a3/ThesisVersioning0_1_0 (github.com)
- Source code of the system:
  - Server side: ngminhthanh12a3/desiot-server at 1.x.x (github.com)
  - ESP32 Gateway: ngminhthanh12a3/DESIoT_ESP32_Gateway at 1.x.x (github.com)

The Available IoT Architecture

The Available IoT Model

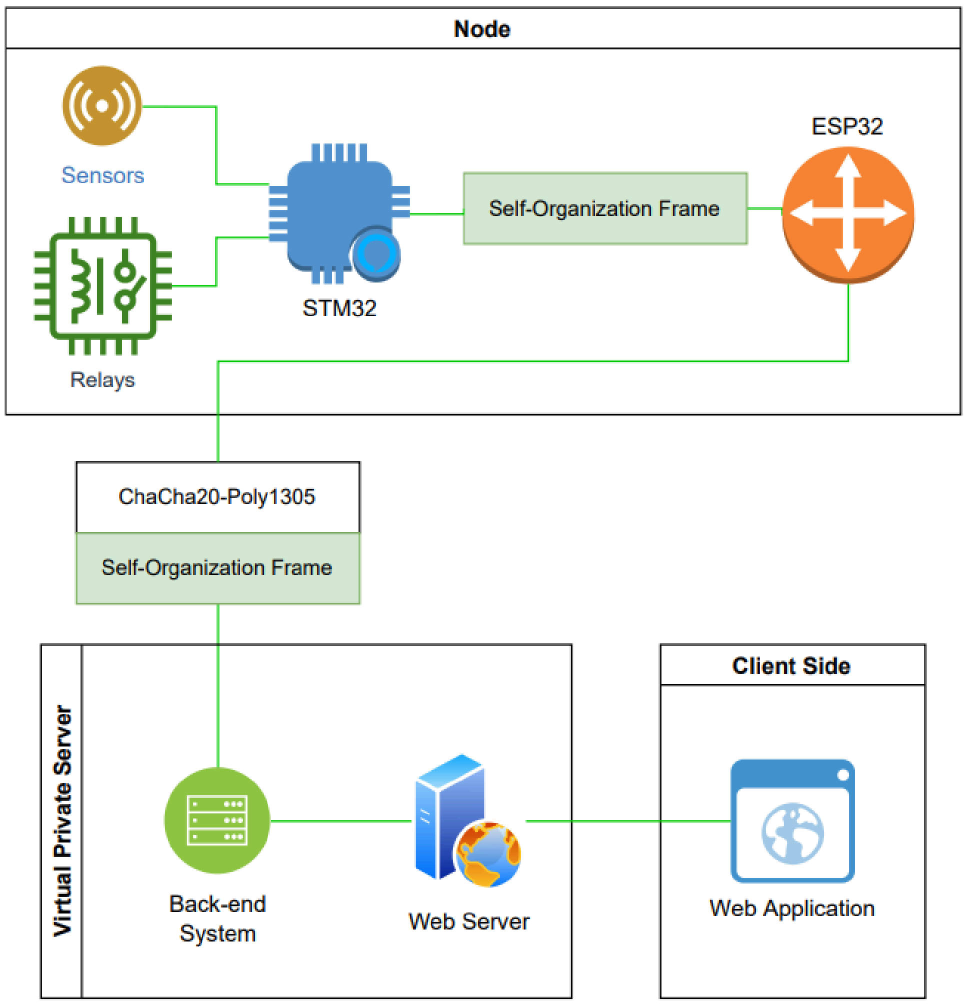
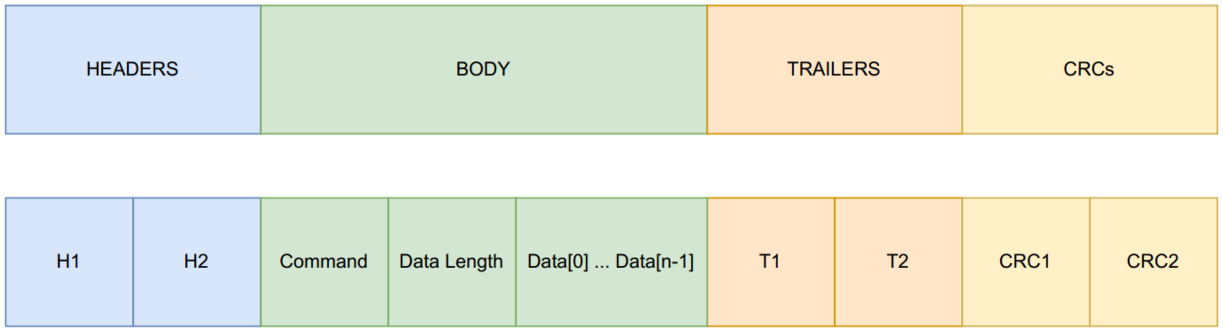


Fig. 5: Implementation of ChaCha20-Poly1305 and Data Framing on the IoT System

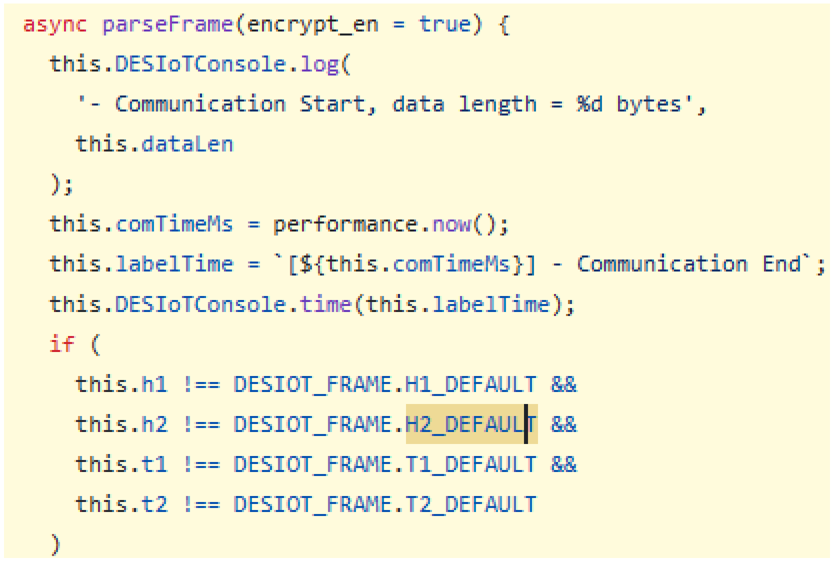
Frame Protocol: Structure and Parsing



Hình 2.2: Cấu trúc frame của hệ thống.

Frame Parsing in the server-side

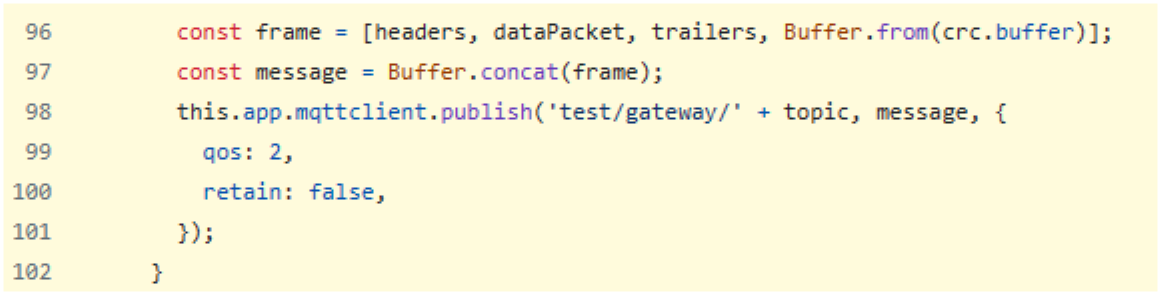
- ○ [desiot-server/lib/src/frameHandler/index.js at 1.x.x · ngminhthanh12a3/desiot-server (github.com)]



```
async parseFrame(encrypt_en = true) {
  this.DESIoTConsole.log(
    '- Communication Start, data length = %d bytes',
    this.dataLen
  );
  this.comTimeMs = performance.now();
  this.labelTime = `[${this.comTimeMs}] - Communication End`;
  this.DESIoTConsole.time(this.labelTime);
  if (
    this.h1 !== DESIOT_FRAME.H1_DEFAULT &&
    this.h2 !== DESIOT_FRAME.H2_DEFAULT &&
    this.t1 !== DESIOT_FRAME.T1_DEFAULT &&
    this.t2 !== DESIOT_FRAME.T2_DEFAULT
  )
```

Frame Composing from the Server

- Before sending a frame to the ESP32 Gateway, the server constructs the frame components following the frame structure.

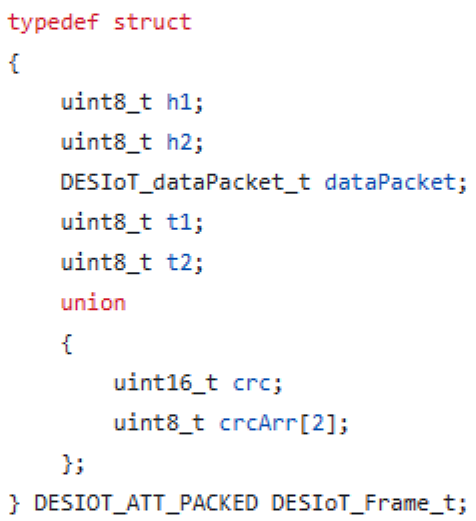


```
        const frame = [headers, dataPacket, trailers, Buffer.from(crc.buffer)];
        const message = Buffer.concat(frame);
        this.app.mqttclient.publish('test/gateway/' + topic, message, {
          qos: 2,
          retain: false,
        });
      }
```

- [desiot-server/lib/utils/DevSyncFrame.js at 1.x.x · ngminhthanh12a3/desiot-server (github.com)]

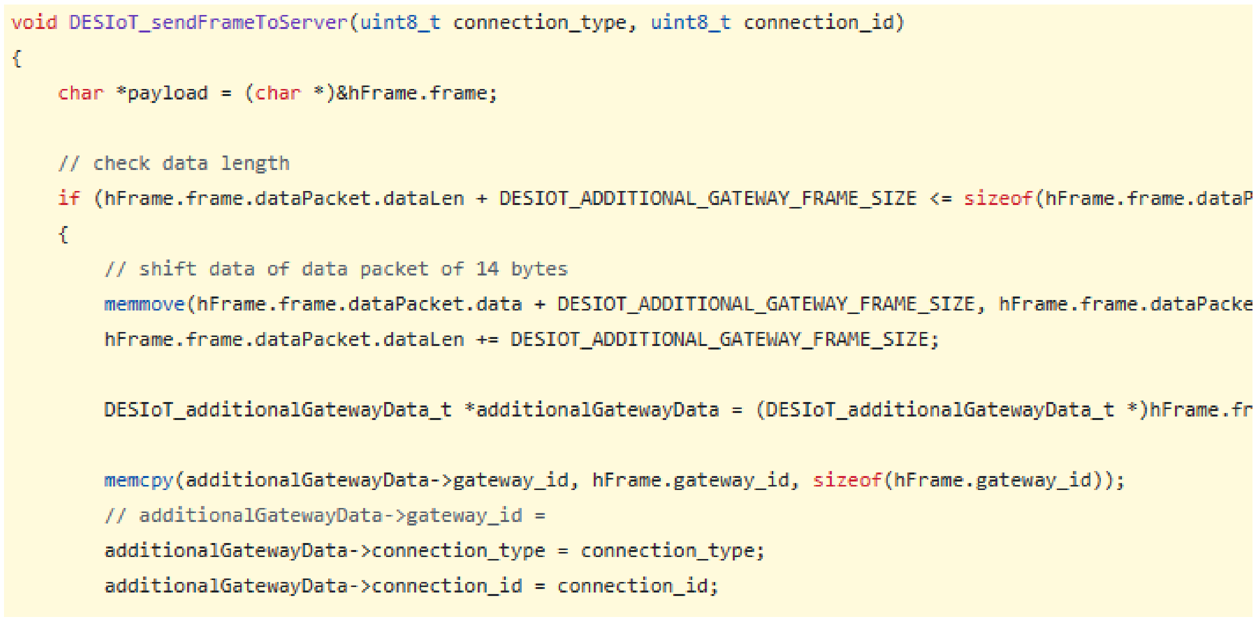
Frame Composing from the ESP32 Gateway

- The frame structure definition of the hardware:
  - [DESIoT_ESP32_Gateway/include/DESIoT_Gateway.h at 1.x.x · ngminhthanh12a3/DESIoT_ESP32_Gateway (github.com)]



```
typedef struct
{
    uint8_t h1;
    uint8_t h2;
    DESIoT_dataPacket_t dataPacket;
    uint8_t t1;
    uint8_t t2;
    union
    {
        uint16_t crc;
        uint8_t crcArr[2];
    };
} DESIOT_ATT_PACKED DESIoT_Frame_t;
```

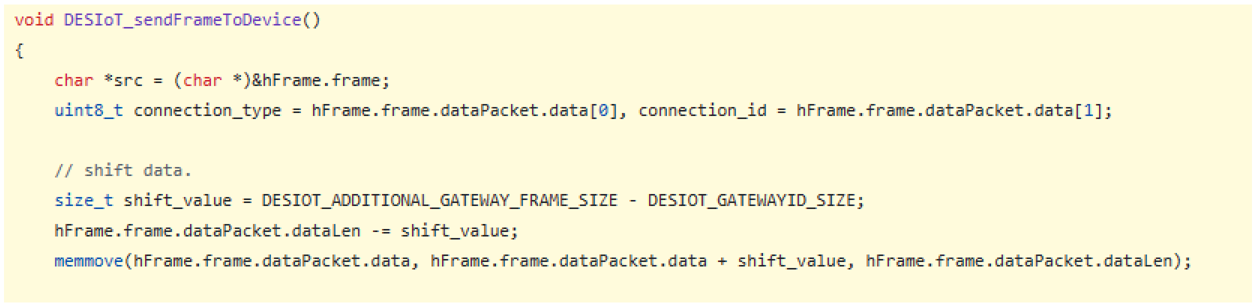
- The composing function manually constructs a frame before sending it to the server:



```
void DESIoT_sendFrameToServer(uint8_t connection_type, uint8_t connection_id)
{
    char *payload = (char *)&hFrame.frame;

    // check data length
    if (hFrame.frame.dataPacket.dataLen + DESIOT_ADDITIONAL_GATEWAY_FRAME_SIZE <= sizeof(hFrame.frame.dataP
    {
        // shift data of data packet of 14 bytes
        memmove(hFrame.frame.dataPacket.data + DESIOT_ADDITIONAL_GATEWAY_FRAME_SIZE, hFrame.frame.dataPacke
        hFrame.frame.dataPacket.dataLen += DESIOT_ADDITIONAL_GATEWAY_FRAME_SIZE;

        DESIoT_additionalGatewayData_t *additionalGatewayData = (DESIoT_additionalGatewayData_t *)hFrame.fr

        memcpy(additionalGatewayData->gateway_id, hFrame.gateway_id, sizeof(hFrame.gateway_id));
        // additionalGatewayData->gateway_id =
        additionalGatewayData->connection_type = connection_type;
        additionalGatewayData->connection_id = connection_id;
```

- ○ [DESIoT_ESP32_Gateway/src/DESIoT_Gateway.cpp at 1.x.x · ngminhthanh12a3/DESIoT_ESP32_Gateway (github.com)]()

- The composing function manually constructs a frame before sending it to the hardware:



```
void DESIoT_sendFrameToDevice()
{
    char *src = (char *)&hFrame.frame;
    uint8_t connection_type = hFrame.frame.dataPacket.data[0], connection_id = hFrame.frame.dataPacket.data[1];

    // shift data.
    size_t shift_value = DESIOT_ADDITIONAL_GATEWAY_FRAME_SIZE - DESIOT_GATEWAYID_SIZE;
    hFrame.frame.dataPacket.dataLen -= shift_value;
    memmove(hFrame.frame.dataPacket.data, hFrame.frame.dataPacket.data + shift_value, hFrame.frame.dataPacket.dataLen);
```

- [DESIoT_ESP32_Gateway/src/DESIoT_Gateway.cpp at 1.x.x · ngminhthanh12a3/DESIoT_ESP32_Gateway (github.com)]()

Frame Com

Hardware Implementation of the ESP32 Gateway

Lightweight Cryptography Implementation

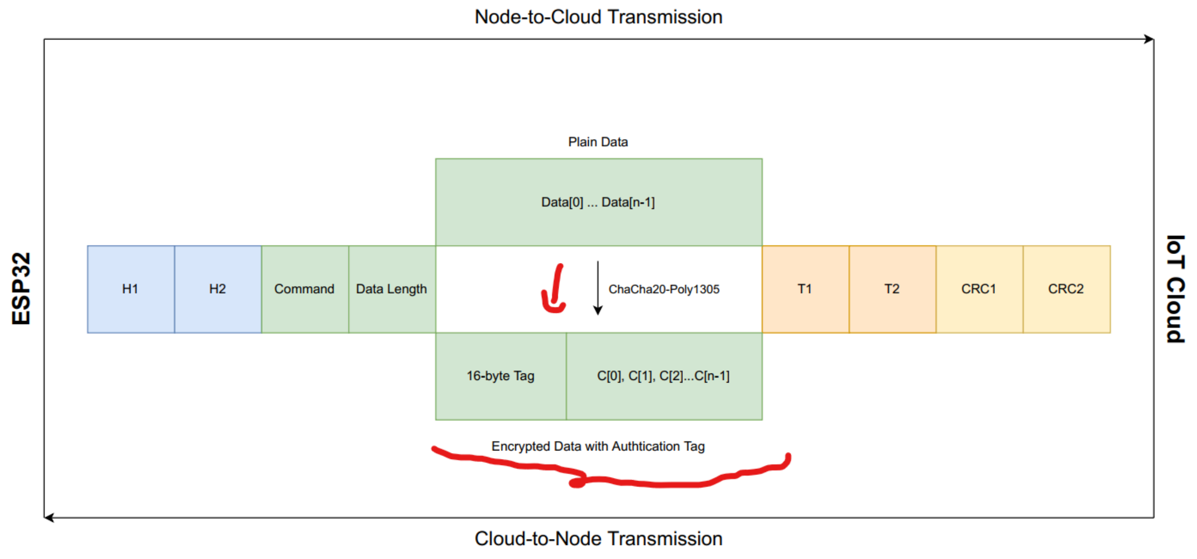

Node-to-Cloud Transmission
ESP32
IoT Cloud
Plain Data
Data[0] ... Data[n-1]
H1
H2
Command
Data Length
ChaCha20-Poly1305
T1
T2
CRC1
CRC2
16-byte Tag
C[0], C[1], C[2]...C[n-1]
Encrypted Data with Authtication Tag
Cloud-to-Node Transmission

Fig. 2: The ChaCha20-Poly1305 Implementation on the Proposed Frame Protocol

Setup Server

- Test the system in your local VM server.

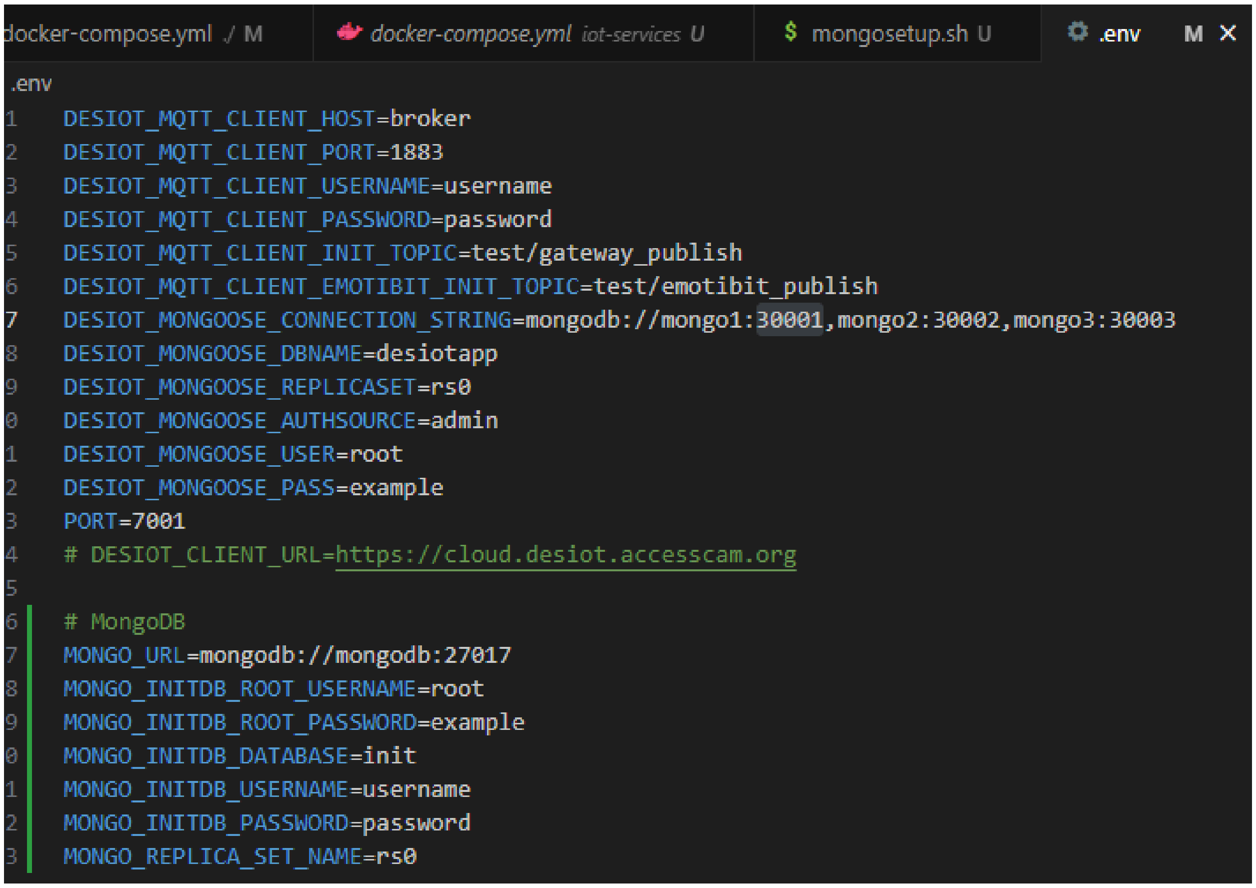
Download the source code

- desiot@desiot:~/desiot-server/testdir/desiot-server$ **git clone --branch QT-Demo https://github.com/ngminhthanh12a3/desiot-server.git**

Setup Database Private Key

- [install make in ubuntu - Tìm trên Google]()
  - “sudo apt-get -y install make”
- Run the following command to initialize the database key:
  - desiot@desiot:~/desiot-server$ **make mongo-key-init**
- Start the system
  - desiot@desiot:~/desiot-server$ **make dev-up**

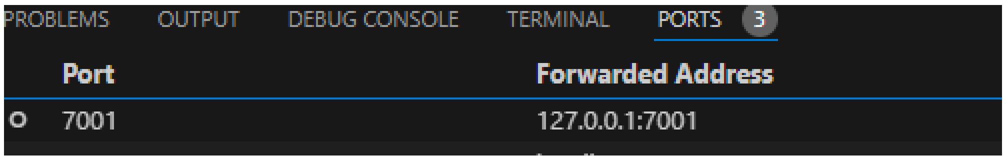
Server configuration environment



```
.env
DESIOT_MQTT_CLIENT_HOST=broker
DESIOT_MQTT_CLIENT_PORT=1883
DESIOT_MQTT_CLIENT_USERNAME=username
DESIOT_MQTT_CLIENT_PASSWORD=password
DESIOT_MQTT_CLIENT_INIT_TOPIC=test/gateway_publish
DESIOT_MQTT_CLIENT_EMOTIBIT_INIT_TOPIC=test/emotibit_publish
DESIOT_MONGOOSE_CONNECTION_STRING=mongodb://mongo1:30001,mongo2:30002,mongo3:30003
DESIOT_MONGOOSE_DBNAME=desiotapp
DESIOT_MONGOOSE_REPLICASET=rs0
DESIOT_MONGOOSE_AUTHSOURCE=admin
DESIOT_MONGOOSE_USER=root
DESIOT_MONGOOSE_PASS=example
PORT=7001
# DESIOT_CLIENT_URL=https://cloud.desiot.accesscam.org

# MongoDB
MONGO_URL=mongodb://mongodb:27017
MONGO_INITDB_ROOT_USERNAME=root
MONGO_INITDB_ROOT_PASSWORD=example
MONGO_INITDB_DATABASE=init
MONGO_INITDB_USERNAME=username
MONGO_INITDB_PASSWORD=password
MONGO_REPLICA_SET_NAME=rs0
```

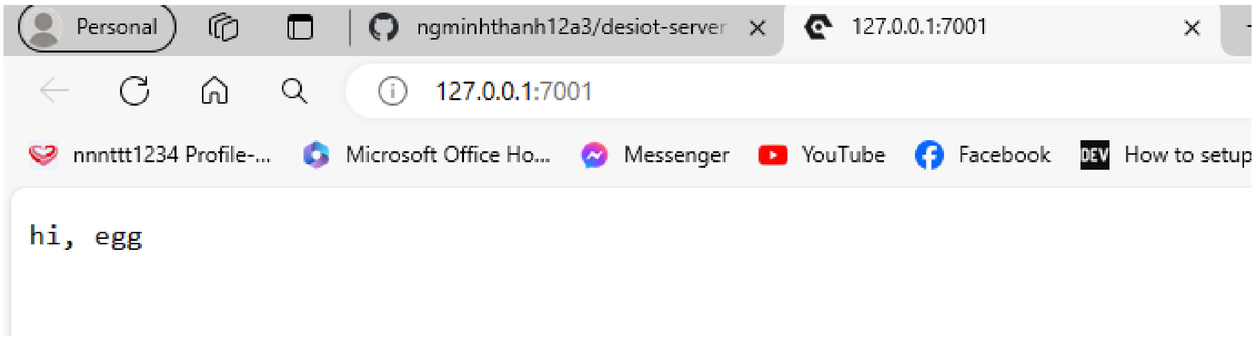
- Chang the configuration environment in the ".env" file if you want to change he **port** of the broker or server.

Test the Server

- 

```
Port    Forwarded Address
7001    127.0.0.1:7001
```

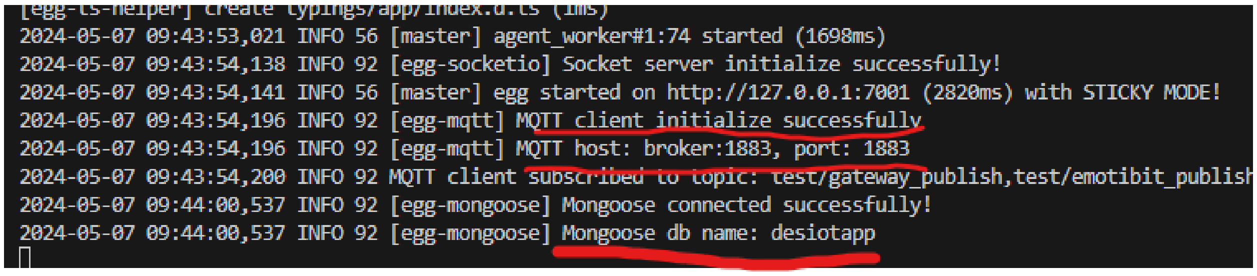
  - Setup the port forwarding.



```
hi, egg
```

-

- View server logs for checking the successful configurations of MQTT Broker and MongoDB connections
    - desiot@desiot:~/desiot-server$ **docker logs -f desiot-server-desiot-server-1**



```
[egg-ts-helper] create typings/app/index.d.ts (1ms)
2024-05-07 09:43:53,021 INFO 56 [master] agent_worker#1:74 started (1698ms)
2024-05-07 09:43:54,138 INFO 92 [egg-socketio] Socket server initialize successfully!
2024-05-07 09:43:54,141 INFO 56 [master] egg started on http://127.0.0.1:7001 (2820ms) with STICKY MODE!
2024-05-07 09:43:54,196 INFO 92 [egg-mqtt] MQTT client initialize successfully
2024-05-07 09:43:54,196 INFO 92 [egg-mqtt] MQTT host: broker:1883, port: 1883
2024-05-07 09:43:54,200 INFO 92 MQTT client subscribed to topic: test/gateway_publish,test/emotibit_publish
2024-05-07 09:44:00,537 INFO 92 [egg-mongoose] Mongoose connected successfully!
2024-05-07 09:44:00,537 INFO 92 [egg-mongoose] Mongoose db name: desiotapp
```

- Re-run the system if any error occur:
    - desiot@desiot:~/desiot-server$ **make dev-reup**