Cloud Service Management on MANET

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March 2023

1 Introduction

This report aims to simulate the process of MANET network and cloud service interaction. The cloud service provides MANET with resource management and traffic monitoring services to improve the operating efficiency of MANET. Traditional MANETs need devices communicate and coordinate with each other. This coordination process is time-consuming and inefficient. It is a good choice to use cloud services to manage MANET in a unified manner. Cloud services can create and manage IDs for devices, and provide services for creating networks, joining networks, and leaving networks, so that devices do not need to go through time-consuming coordination The process can quickly create, join, and exit the network. The goal of this project is to use cloud services to manage MANET in a unified way and improve its operating efficiency. By combining mobile devices and cloud services, the coordination time between devices can be reduced and the operating efficiency of the network can be improved. The project consists of client, server, database, and Kubernetes.

Client The client is mainly a terminal-based program. Each terminal running client program represents a mobile device, and each device has its own location. The client is responsible for communicating with the server, sending requests and receiving responses to complete operations such as creating, joining and leaving MANET. The main functions of the client are as follows:

1. Registration: After the user enters the user name and password, the user requests the server to register an account and obtains the account ID.
2. Login: The user logs in with username and password.
3. Create a network: the user requests to create a network, the server registers a network for the user, and returns the network ID
4. Join the network: the user requests to join the network, the server will list all available networks nearby for the user to choose, after the user selects, the server will join the network for the user and return the network ID. If the network is full, the server will register a new network and join the user, and return the new network ID.

5. Leave the network: The user requests to leave the network, and the server removes the user from the network. If the current number of users on the network is 0, mark the network as terminated.

6. Logout: The user logs out of the account. Users can re-register or log in by entering their username and password again.

7. Exit program: The user exits the program. The client program will end.

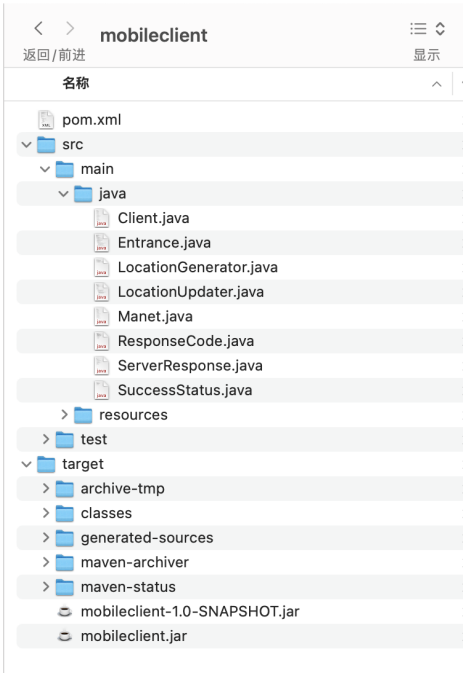


Figure 1: mobileclient project

Server Unified management of MANET by cloud services can significantly improve the operating efficiency of the network and reduce the coordination time between devices. Several key points and simulation descriptions of cloud service functions are as follows:

1. Network topology management: Cloud services need to be able to detect the location of mobile devices and create and maintain network topology for them. This may require the use of technologies such as GPS to locate the device. In this project, each client will randomly generate a new location every once in a while to simulate movement, and the client will upload the updated location to the cloud service.

2. Routing management: In order to ensure that data can be transmitted correctly in the network, cloud services need to maintain and update routing

tables. This may require the use of some existing routing protocols such as AODV, OLSR, etc. This project assumes that routing management functionality already exists and will not be implemented.

3. Resource management: Cloud services need to monitor device resource usage and ensure resource allocation is reasonable. This may require the use of some machine learning algorithms to predict the future resource requirements of the device. In this project, the server will respond to the client's request (register, log in, create a network, join a specified network, exit the network), and assign IDs to devices and networks. In case of MANET capacity overload, the server will automatically split the network and create a new MANET for the fourth device. The server is also responsible for writing or reading data into the database to record information about devices and networks.

4. Latency: Delays can occur as the mobile device needs to send a request to the cloud service and wait for a response. To minimize latency, the distance between the cloud service and the device can be kept as short as possible and the request-response process optimized. In this project, the default server is close to the device with low latency.

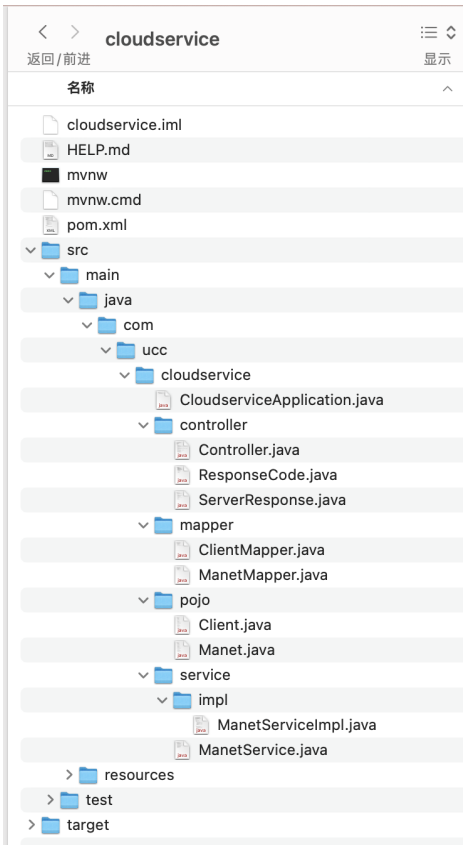


Figure 2: service project

Database The database includes two tables, one table stores device information, and the other table stores network information. The device table stores the ID, location and other related information of the device, and the network table stores the ID, capacity and other related information of the network. The function of the database is to store and manage the information of the equipment and the network, so that the server can manage and monitor it.

1. Client Table:

```
CREATE TABLE client (
    id INT NOT NULL AUTO_INCREMENT,
    longitude FLOAT NOT NULL,
    latitude FLOAT NOT NULL,
    netid INT NOT NULL,
    username VARCHAR(255) NOT NULL,
    password VARCHAR(255) NOT NULL,
    PRIMARY KEY (id));
```

2. Manet Table:

```
CREATE TABLE manet (
netid INT NOT NULL AUTO_INCREMENT,
netstatus BIT(1) NOT NULL,
start_time DATETIME NOT NULL,
PRIMARY KEY (netid));
```

Kubernetes Kubernetes is a versatile platform designed to manage containerized applications. In this particular project, we will be deploying the server onto a local Kubernetes cluster that consists of two nodes. To achieve optimal performance, we will utilize two pods to run the server program. The Kubernetes cluster will evenly distribute each pod, running one pod on each node, and utilize a service to expose the port. The use of Kubernetes allows for simplified deployment and management of applications, ultimately leading to improved reliability and scalability. Applications can be easily deployed and managed using Kubernetes, improving the reliability and scalability of applications.

2 Deployment

The deployment process is mainly as follows:

1. Package the client program into a jar file so that it can be run on the terminal.

2. Package the server program into a jar, write a Dockerfile for it, and build image for release.

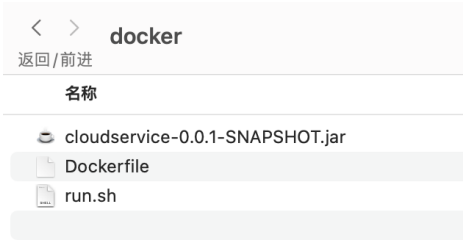


Figure 3: docker folder

3. Create a Kubernetes cluster and create 2 nodes. After that, create the app.yaml file and deploy the program on kubernetes.Create a service and expose the node port. And forward the port to localhost:8080

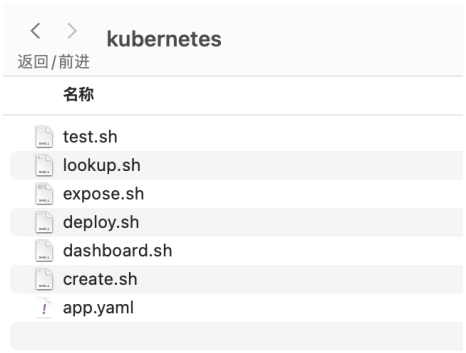


Figure 4: kubernetes folder

The deployment results are as follows. We created a cluster with 2 nodes, then deployed the application to the cluster, and created the corresponding service to expose the service port of each node. Through the minikube dashboard, we can see the basic situation of nodes, pods, and services.

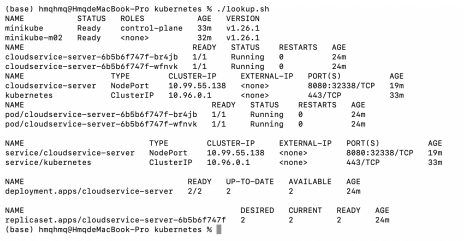


Figure 5: cluster information

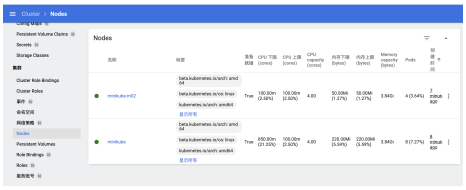


Figure 6: nodes information

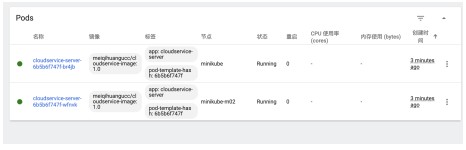


Figure 7: pods information

Figure 8: service information

3 Result

We created 4 clients to test the functions of registering and logging in, creating a network, joining a network, and leaving a network. First we create 4 clients, register meiqi, meiqi2, meiqi3, meiqi4 accounts for each client 1, 2, 3, 4 respectively. Second let client 1 create network 1 and the other three join that network 1. Since the network capacity is 3, when a client 4 wants to join the network 1, the system will detect that the capacity is overloaded, create and return a new network 2 . After that, we let client 3 switch network 1 to network 4. So the current capacity of both networks is 2. Then let client 1, 2 both exit network 1, network 1 will have no devices to join, and the state will be marked as terminated . Finally we exit the client.

3.1 Register

We first create one client in one terminal. Here is an example of creating an account in a terminal.

```
(base) hmqhmq@HmqdeMacBook-Pro target % java -jar mobileclient.jar
Welcome to the mobile game!
Please enter your username to register or login:
meiqi
username: meiqi
Please enter your password to register or login:
123
password: 123
Hello meiqi!
Here is your client information:
You need to login or register first.
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
2
Login failed for user: meiqi - {"responseCode":"LOGIN_ERROR","data":null}
Hello meiqi!
Here is your client information:
You need to login or register first.
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
1
Registration successful
Hello meiqi!
Here is your client information:
Your client ID is: 1
You didn't join any network.
You may need to create a network first
Your current location is: (8.127029418945312, -97.75045013427734)
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
```

Figure 9: register user1 example

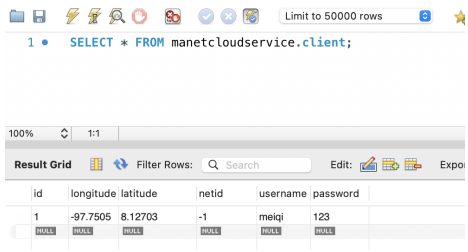


Figure 10: Database: register user1 example

3.2 Create/Join Manet

3.2.1 create network in clien1

We then create a network in client1.

```
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
4
currenctly no network nearby
Hello meiqi!
Here is your client information:
Your client ID is: 1
You didn't join any network.
You may need to create a network first
Your current location is: (8.127029418945312, -97.75045013427734)
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
3
Manet created successfully for user: meiqi
Hello meiqi!
Here is your client information:
Your client ID is: 1
Your network ID is: 1
Your current location is: (8.127029418945312, -97.75045013427734)
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
```

Figure 11: user1 create manet

We can see the client table from database: the manet id column value change from -1 to 1.

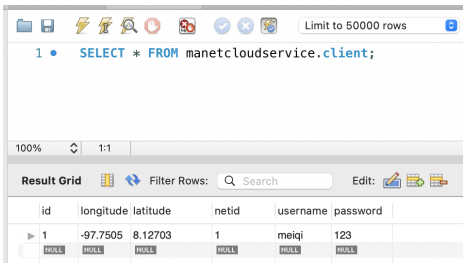


Figure 12: Database: user1 in client table

The manet table add a new row to store the manet1 information.

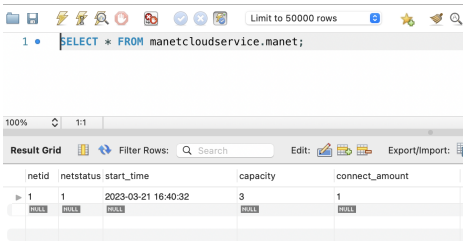


Figure 13: Database: manet1 in manet table

3.2.2 create clien2 and client3 and join network1

We then create the second client and join the manet.

Figure 14: user2 register

```
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
4
The following manet networks are available:
Manet ID: 1
Status: Active
Start Time: Tue Mar 21 16:40:32 GMT 2023
CurrentConnectAmount: 1
Capacity: 3
Please enter the net_id of the Manet you want to join:
```

Figure 15: user2 choose available manet

```
The following manet networks are available:
Manet ID: 1
Status: Active
Start Time: Tue Mar 21 16:40:32 GMT 2023
CurrentConnectAmount: 1
Capacity: 3
Please enter the net_id of the Manet you want to join:
1
Manet joined successfully
Hello meiqi2!
Here is your client information:
Your client ID is: 2
Your network ID is: 1
Your current location is: (13.359474182128906, 178.84332275390625)
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
```

Figure 16: user2 joined the manet

We can see the new row from client table: It indicates that user2 also join the manet1.

Result Grid | Filter Rows: Search | Edit:

id	longitude	latitude	netid	username	password
1	-97.7505	8.12703	1	meiqi	123
2	178.843	13.3595	1	meiqi2	123
NULL	NULL	NULL	NULL	NULL	NULL

Figure 17: Database: user2 in client table

The manet also changed the current connected amount from 1 to 2.

Result Grid | Filter Rows: Search | Edit: | Export/Import:

netid	netstatus	start_time	capacity	connect_amount
1	1	2023-03-21 16:40:32	3	2
NULL	NULL	NULL	NULL	NULL

Figure 18: Database: manet1 changed the connected amount in manet table

We then create user3 and also join network1.

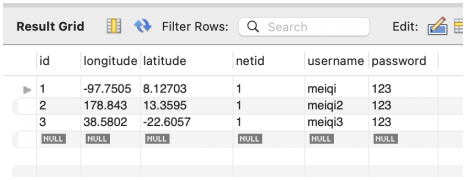
```
(base) hmqhmq@HmqdeMacBook-Pro target % java -jar mobileclient.jar
Welcome to the mobile game!
Please enter your username to register or login:
meiqi3
username: meiqi3
Please enter your password to register or login:
123
password: 123
Hello meiqi3!
Here is your client information:
You need to login or register first.
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
1
Registration successful
Hello meiqi3!
Here is your client information:
Your client ID is: 3
You didn't join any network.
You may need to create a network first
Your current location is: (-22.605735778808594, -3.1055908203125)
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
2
Login successful for user: meiqi3
Hello meiqi3!
Here is your client information:
Your client ID is: 3
You didn't join any network.
You may need to create a network first
Your current location is: (-22.6057, 29.546615600585938)
```

Figure 19: user3 register

```
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
4
The following manet networks are available:
Manet ID: 1
Status: Active
Start Time: Tue Mar 21 16:40:32 GMT 2023
CurrentConnectAmount: 2
Capacity: 3
Please enter the net_id of the Manet you want to join:
1
Manet joined successfully
Hello meiqi3!
Here is your client information:
Your client ID is: 3
Your network ID is: 1
Your current location is: (-22.6057, 60.9539794921875)
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
```

Figure 20: user3 choose and join manet1

We can see the new row from client table: It indicates that user3 also join the manet1.

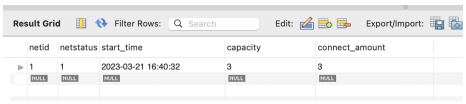


Result Grid Filter Rows: Search Edit:

id	longitude	latitude	netid	username	password
1	-97.7505	8.12703	1	meiqi	123
2	178.843	13.3595	1	meiqi2	123
3	38.5802	-22.6057	1	meiqi3	123
NULL	NULL	NULL	NULL	NULL	NULL

Figure 21: Database: user3 in client table

The manet also changed the current connected amount from 2 to 3, Which reaches the capacity of network.



Result Grid Filter Rows: Search Edit: Export/Import:

netid	netstatus	start_time	capacity	connect_amount
1	1	2023-03-21 16:40:32	3	3
NULL	NULL	NULL	NULL	NULL

Figure 22: Database: manet1 changed the connected amount in manet table

3.2.3 create user4 and join the network1

We then create user4 and want to join the network1, because it reaches the limit of network1. The system will create a new network and register user4 to it.

```
(base) hmqhmq@HmqdeMacBook-Pro target % java -jar mobileclient.jar
Welcome to the mobile game!
Please enter your username to register or login:
meiqi4
username: meiqi4
Please enter your password to register or login:
123
password: 123
Hello meiqi4!
Here is your client information:
You need to login or register first.
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
1
Registration successful
Hello meiqi4!
Here is your client information:
Your client ID is: 4
You didn't join any network.
You may need to create a network first
Your current location is: (81.69157409667969, -101.05563354492188)
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
4
The following manet networks are available:
Manet ID: 1
Status: Active
Start Time: Tue Mar 21 16:40:32 GMT 2023
CurrentConnectAmount: 3
Capacity: 3
Please enter the net_id of the Manet you want to join:
1
Manet joined successfully
Reach to Manet Capacity, Need to Split
Hello meiqi4!
Here is your client information:
Your client ID is: 4
Your network ID is: 2
Your current location is: (81.69157409667969, -101.05563354492188)
```

Figure 23: create user4 and join the manet1

we can also see the user4 joined the manet2 in database.

id	longitude	latitude	netid	username	password
1	-97.7505	8.12703	1	meiqi	123
2	178.843	13.3595	1	meiqi2	123
3	33.2585	-22.6057	1	meiqi3	123
4	-101.056	81.6916	2	meiqi4	123
NULL	NULL	NULL	NULL	NULL	NULL

Figure 24: user4 join the manet2

netid	netstatus	start_time	capacity	connect_amount
1	1	2023-03-21 16:40:32	3	3
2	1	2023-03-21 16:53:27	3	1
NULL	NULL	NULL	NULL	NULL

Figure 25: manet2 information

3.3 Leave Manet

Let user 3 leave network 1 and join network 2, you can see the change of network capacity and the change of user 3's network ID.

```
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
5
Manet left successfully
Hello meiqi3!
Here is your client information:
Your client ID is: 3
You didn't join any network.
You may need to create a network first
Your current location is: (-22.6057, 18.699806213378906)
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
```

Figure 26: user3 leave network1

id	longitude	latitude	netid	username	password
1	-97.7505	8.12703	1	meiqi	123
2	178.843	13.3595	1	meiqi2	123
3	-70.7586	-22.6057	-1	meiqi3	123
4	-101.056	81.6916	2	meiqi4	123
NULL	NULL	NULL	NULL	NULL	NULL

Figure 27: Database client table: user3 leave the network1

netid	netstatus	start_time	capacity	connect_amount
1	1	2023-03-21 16:40:32	3	2
2	1	2023-03-21 16:53:27	3	1
NULL	NULL	NULL	NULL	NULL

Figure 28: Database manet table: user3 leave the network1

```
Hello meiqi3!
Here is your client information:
Your client ID is: 3
You didn't join any network.
You may need to create a network first
Your current location is: (-22.6057, 18.699806213378906)
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
4
The following manet networks are available:
Manet ID: 1
Status: Active
Start Time: Tue Mar 21 16:40:32 GMT 2023
CurrentConnectAmount: 2
Capacity: 3
Manet ID: 2
Status: Active
Start Time: Tue Mar 21 16:53:27 GMT 2023
CurrentConnectAmount: 1
Capacity: 3
Please enter the net_id of the Manet you want to join:
2
Manet joined successfully
Hello meiqi3!
Here is your client information:
Your client ID is: 3
Your network ID is: 2
Your current location is: (-22.6057, 56.5811767578125)
```

Figure 29: user3 join network2

Result Grid Filter Rows: Search Edit:

id	longitude	latitude	netid	username	password
1	-97.7505	8.12703	-1	meiqi	123
2	178.843	13.3595	-1	meiqi2	123
3	3.83755	-22.6057	2	meiqi3	123
4	-101.056	81.6916	2	meiqi4	123
NULL	NULL	NULL	NULL	NULL	NULL

Figure 30: Database client:user3 join network2

netid	netstatus	start_time	capacity	connect_amount
1	1	2023-03-21 16:40:32	3	2
2	1	2023-03-21 16:53:27	3	2
NULL	NULL	NULL	NULL	NULL

Figure 31: Database Manet:user3 join network2

After that, let users 1 and 2 both leave network 1, and you can see the network status changes, and the network IDs of users 1 and 2 change to -1, indicating that they have exited the network.

```
Hello meiqi!
Here is your client information:
Your client ID is: 1
Your network ID is: 1
Your current location is: (8.127029418945312, -97.75045013427734)
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
5
Manet left successfully
Hello meiqi!
Here is your client information:
Your client ID is: 1
You didn't join any network.
You may need to create a network first
Your current location is: (8.127029418945312, -97.75045013427734)
```

Figure 32: user1 leave network1

```
Manet joined successfully
Hello meiqi2!
Here is your client information:
Your client ID is: 2
Your network ID is: 1
Your current location is: (13.359474182128906, 178.84332275390625)
Please choose from the following options:
1. Register
2. Login
3. Create MANET
4. Join MANET
5. Leave MANET
6. Logout
7. Exit
8. Check Device
5
Manet left successfully
Hello meiqi2!
Here is your client information:
Your client ID is: 2
You didn't join any network.
You may need to create a network first
Your current location is: (13.359474182128906, 178.84332275390625)
```

Figure 33: user2 leave network1

Result Grid | Filter Rows: Search | Edit:

id	longitude	latitude	netid	username	password
1	-97.7505	8.12703	-1	meiqi	123
2	178.843	13.3595	-1	meiqi2	123
3	3.83755	-22.6057	2	meiqi3	123
4	-101.056	81.6916	2	meiqi4	123
NULL	NULL	NULL	NULL	NULL	NULL

Figure 34: Database client table: user1 and user2 leave network1

Result Grid | Filter Rows: Search | Edit: | Export/Import:

netid	netstatus	start_time	capacity	connect_amount
1	0	2023-03-21 16:40:32	3	0
2	1	2023-03-21 16:53:27	3	2
NULL	NULL	NULL	NULL	NULL

Figure 35: Database manet table: user1 and user2 leave network1

4 Conclusion

In this experiment, we simulated scenarios involving Mobile Ad hoc Networks (MANETs) and cloud services. By utilizing cloud services, we were able to manage device IP, network IP, traffic detection, and other related factors for

MANETs. This ultimately led to an increase in the operational efficiency of MANETs.