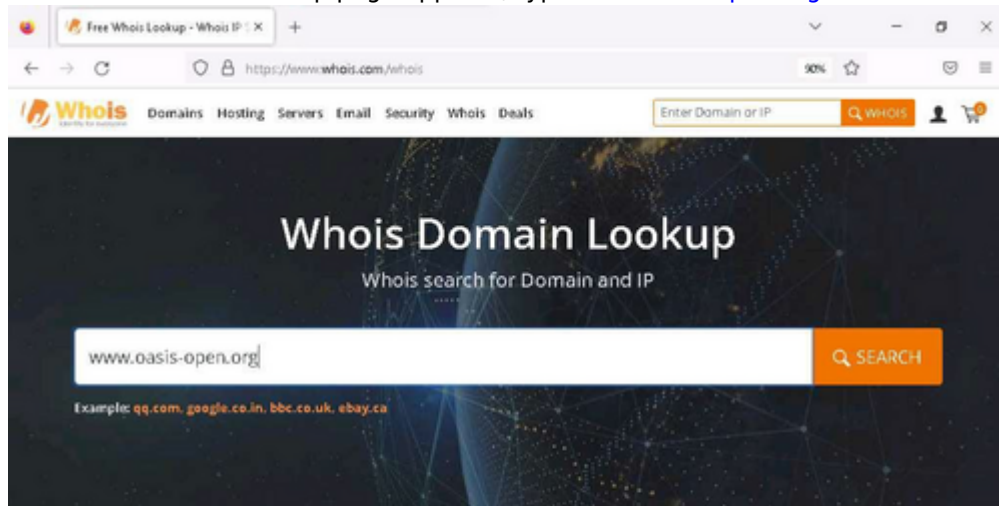


Lab Module 18 IoT and OT Hacking

Lab 1: Perform Footprinting using Various Footprinting Techniques

Task 1: Gather Information using Online Footprinting Tools

1. Launch any web browser, go to <https://www.whois.com/whois> (here, we are using Mozilla Firefox).
2. The Whois Domain Lookup page appears; type www.oasis-open.org in the search field and click SEARCH.



Frequently Asked Questions

+ What is a Whois domain lookup?

File Explorer

1. Oasis is an organization that has published the MQTT v5.0 standard, which represents a significant leap in the refinement and capability of the messaging protocol that already powers IoT.

3. The result appears, displaying the following information, as shown in the screenshots: Domain Information, Registrant Contact, and Raw Whois Data.

Raw Whois Data

```

Domain Name: oasis-open.org
Registry Domain ID: 2bc33180c6aa48c182b09e4f887737bd-LROR
Registrar WHOIS Server: http://whois.directnic.com
Registrar URL: http://www.directnic.com
Updated Date: 2024-01-23T07:30:05Z
Creation Date: 1998-03-04T05:00:00Z
Registry Expiry Date: 2025-03-03T05:00:00Z
Registrar: DNC Holdings, Inc.
Registrar IANA ID: 291
Registrar Abuse Contact Email: abuse@directnic.com
Registrar Abuse Contact Phone: +1.8778569598
Domain Status: clientDeleteProhibited https://icann.org/epp#clientDeleteProhibited
Domain Status: clientTransferProhibited https://icann.org/epp#clientTransferProhibited
Domain Status: clientUpdateProhibited https://icann.org/epp#clientUpdateProhibited
Registry Registrant ID: REDACTED FOR PRIVACY
Registrant Name: REDACTED FOR PRIVACY
Registrant Organization: OASIS Open
Registrant Street: REDACTED FOR PRIVACY
Registrant City: REDACTED FOR PRIVACY
Registrant State/Province: NA
Registrant Postal Code: REDACTED FOR PRIVACY
Registrant Country: US
Registrant Phone: REDACTED FOR PRIVACY
Registrant Phone Ext: REDACTED FOR PRIVACY
Registrant Fax: REDACTED FOR PRIVACY
Registrant Fax Ext: REDACTED FOR PRIVACY
Registrant Email: Please query the RDDS service of the Registrar of Record identified in this ou
  
```

1. This information is about the organization that has developed the MQTT protocol, and it might help keep track of the modifications and version changes of the target protocol.
4. Now, open a new tab, and go to <https://www.exploit-db.com/google-hacking-database>.
5. The Google Hacking Database page appears; type SCADA in the Quick Search field and press Enter.

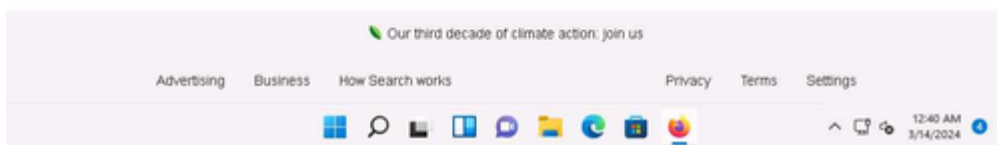
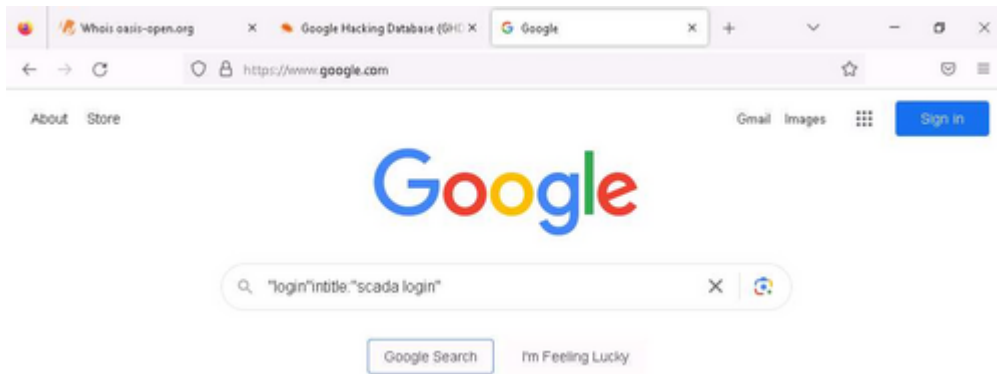
Google Hacking Database

Quick Search: SCADA

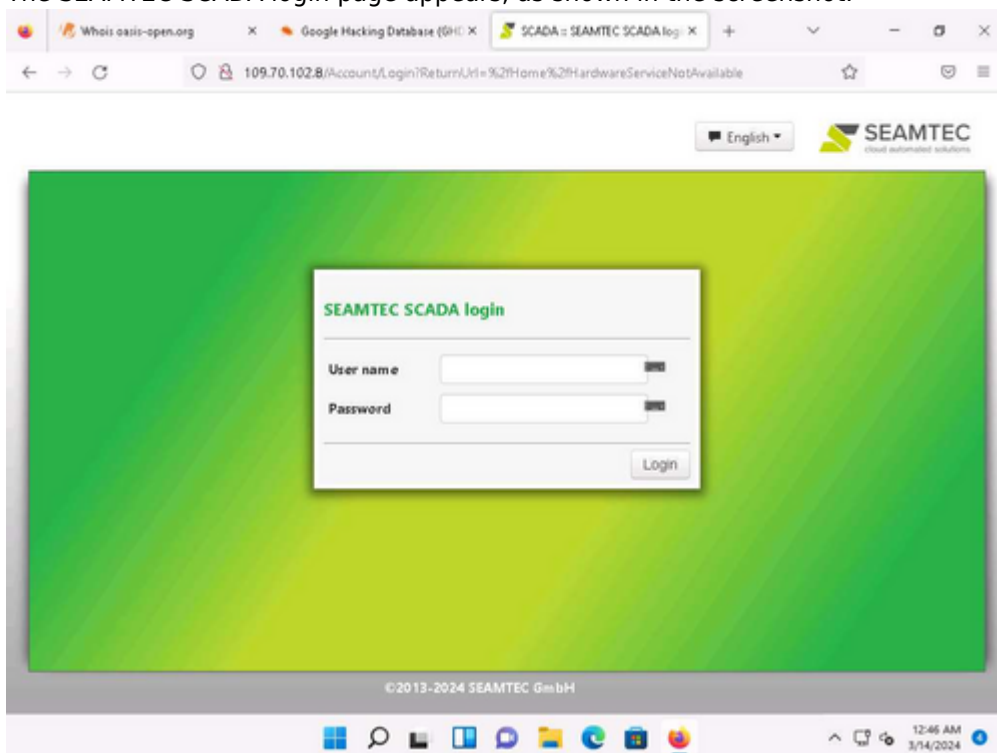
Date Added	Dork	Category	Author
2023-04-06	inurl:"/scada-vis"	Files Containing Juicy Info	Parsa Rezaie Khasbani
2021-10-04	intitle:"index of SCADA"	Sensitive Directories	Romell Marin Cordoba
2021-09-20	intitle:inurl "SCADA login"	Pages Containing Login Portals	Cyber Shelby
2021-09-16	intitle:"CirCarLife Scada" inurl:/html/index.html	Various Online Devices	Alexandros Pappas
2020-05-28	"login" intitle:"scada login"	Pages Containing Login Portals	Alexandros Pappas
2019-04-22	intitle:"index of" scada	Sensitive Directories	Aman Bhandwaj
2018-04-06	"login" intitle:"scada login"	Pages Containing Login Portals	Bruno Schmid

Showing 1 to 7 of 7 entries (filtered from 7,915 total entries)

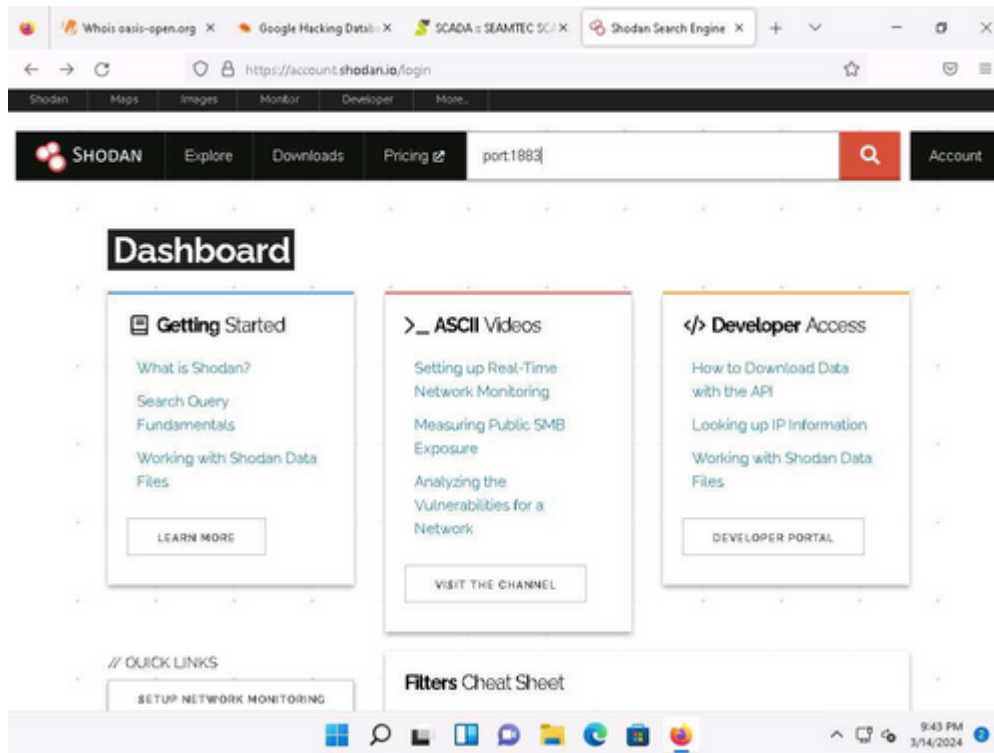
6. Open a new tab and go to <https://www.google.com>. In the search field, enter «login» intitle:«scada login».



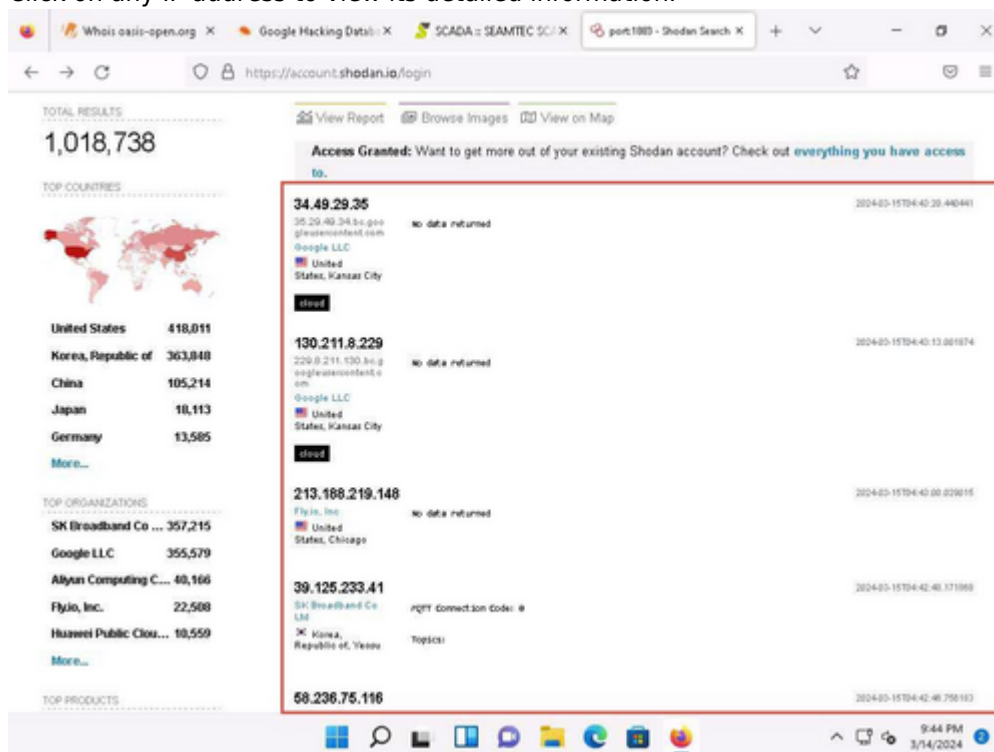
1. Advanced Google hacking refers to the art of creating complex search engine queries by employing advanced Google operators to extract sensitive or hidden information about a target company from the Google search results.
7. The SEAMTEC SCADA login page appears, as shown in the screenshot.



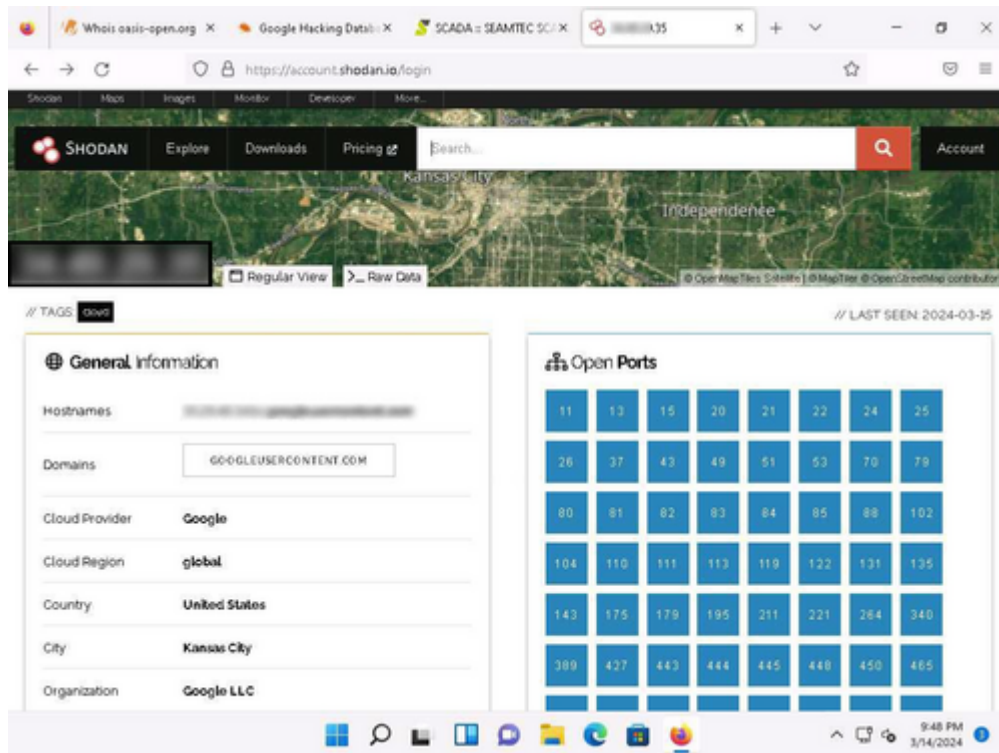
8. Similarly, you can use advanced search operators such as `intitle:«index of» scada` to search sensitive SCADA directories that are exposed on sites.
9. Now, in the browser window, open a new tab and go to <https://account.shodan.io/login>.
10. The Login with Shodan page appears; enter your username and password in the Username and Password fields, respectively; and click Login. If you do not have an existing account, then go to the Register option to register yourself .
11. The Account Overview page appears, which displays the account-related information. Click on Shodan on top-left corner of the window to go to the main page of Shodan.
12. The Shodan main page appears; type `port:1883` in the address bar and press Enter.



1. Port 1883 is the default MQTT port; 1883 is defined by IANA as MQTT over TCP.
13. Click on any IP address to view its detailed information.



14. Detailed results for the selected IP address appears, displaying information regarding Ports, Services, Hostnames, ASN, etc. as shown in the screenshot.

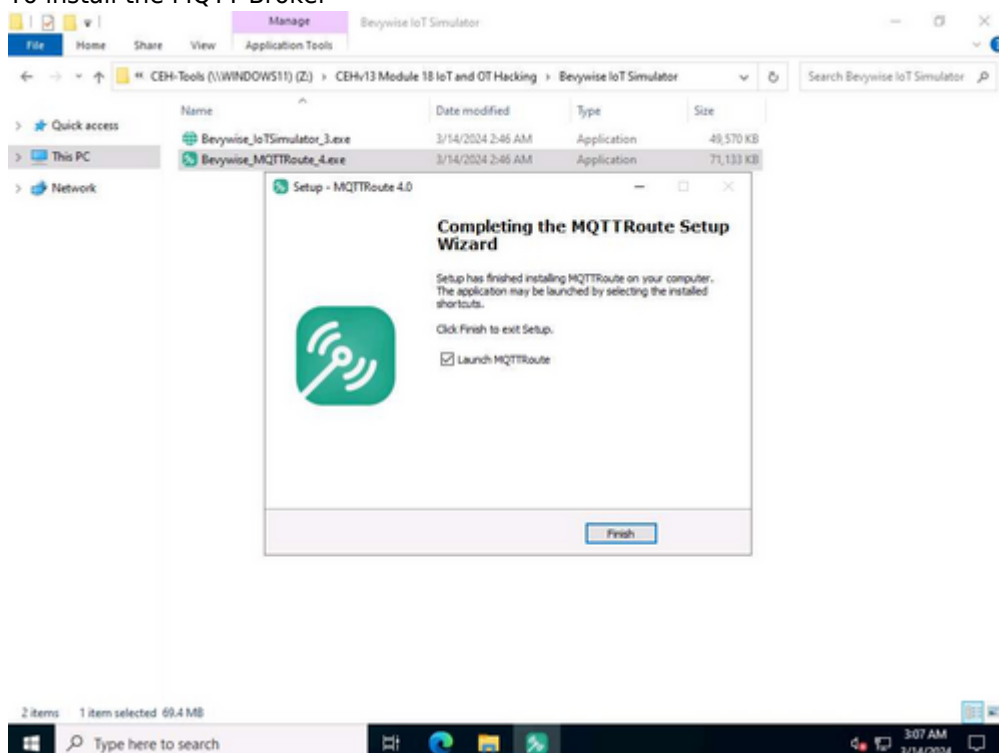


15. Similarly, you can gather additional information on a target device using the following Shodan filters:
 1. Search for Modbus-enabled ICS/SCADA systems: «port:502»
 2. Search for SCADA systems using PLC name: «Schneider Electric»
 3. Search for SCADA systems using geolocation: «SCADA Country:US»»
16. Using Shodan, you can obtain the details of SCADA systems that are used in water treatment plants, nuclear power plants, HVAC systems, electrical transmission systems, home heating systems, etc.

Lab 2: Capture and Analyze IoT Device Traffic

Task 1: Capture and Analyze IoT Traffic using Wireshark

1. To install the MQTT Broker



2. The MQTTRoute will execute and the command prompt will appear. You can see the TCP port using 1883.

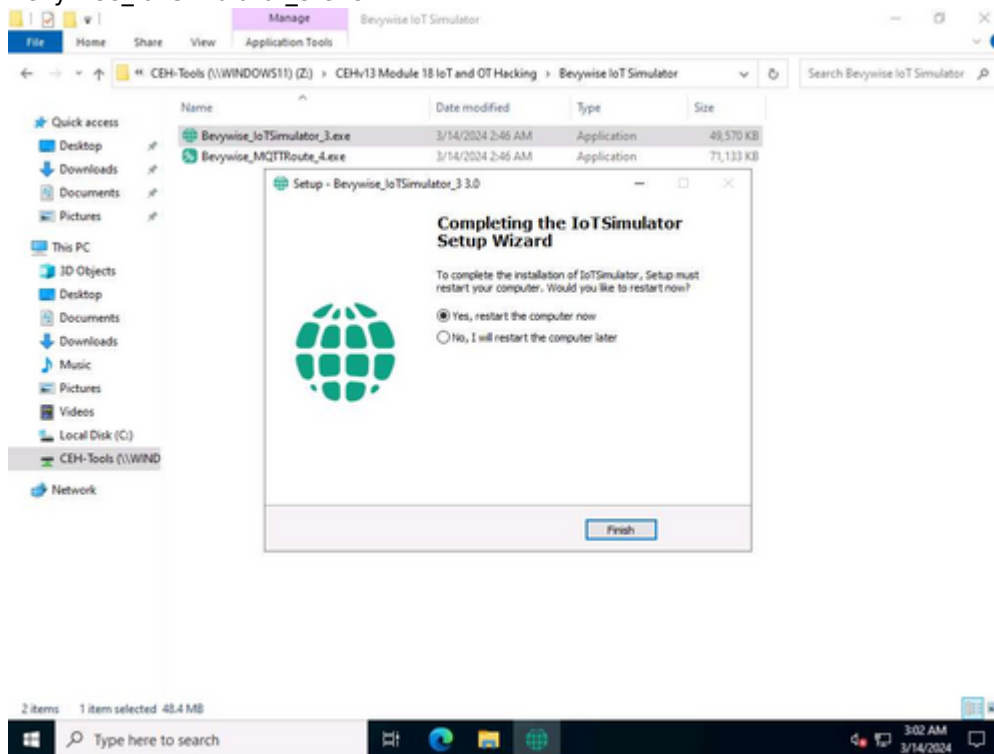
```
Select C:\Bevywise\MQTTRoute\lib\MQTTRoute.exe
[MQTTROUTE]14-03-2024 02:51:49 - Bevywise MQTTRoute 4.0 - build 1122-001
[MQTTROUTE]14-03-2024 02:51:50 - Bevywise HTTP UI WebSocket - Listening on port 8081 for clients..

This software is licensed to 'Bevywise Networks'. This Software is for the sole use of the Licensee and the Licensee cannot r
ent, lease, sell, assign, or transfer rights to the Software. This software is protected by copyright laws.

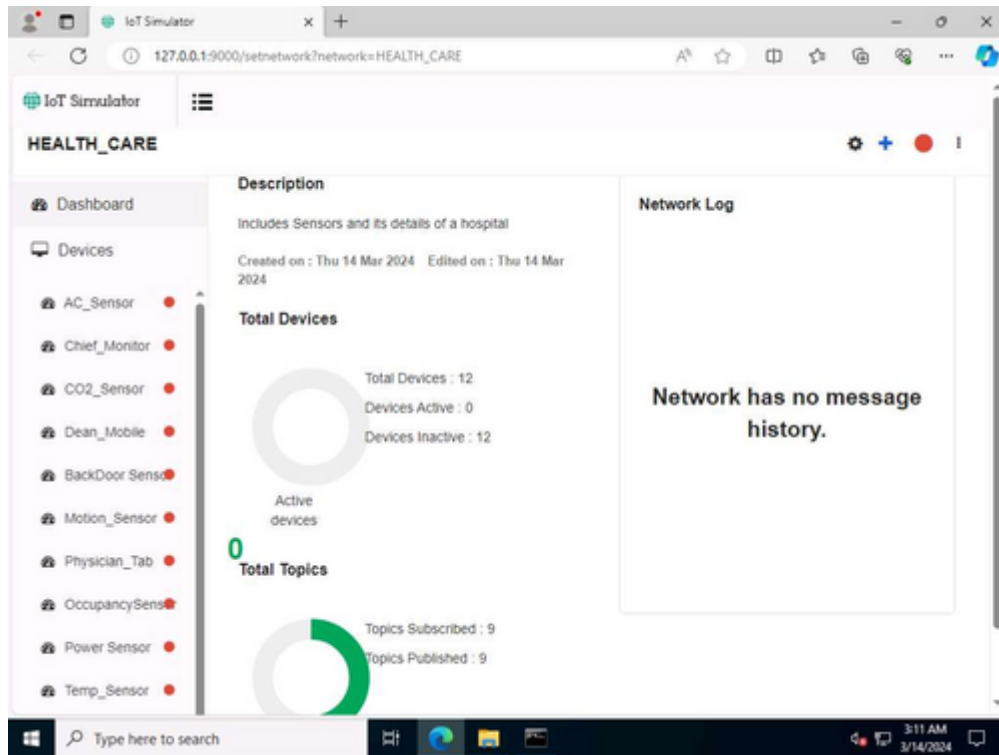
Licensed Clients:10
Licensed for any MAC address

[MQTTROUTE]14-03-2024 02:51:50 - You are using - MQTTRoute - DEVELOPER version
[MQTTROUTE]14-03-2024 02:51:50 - You can connect upto 10 clients
[MQTTROUTE]14-03-2024 02:51:50 - TCP Port - 1883 WebSocket Port - 10443
[MQTTROUTE]14-03-2024 02:51:50 - View your connected devices via your browser at - http://localhost:8080 or http://<machine-1
px:8080
[MQTTROUTE]14-03-2024 02:51:50 - Authentication Disabled
[MQTTROUTE]14-03-2024 02:51:50 - Remote Authentication Disabled
```

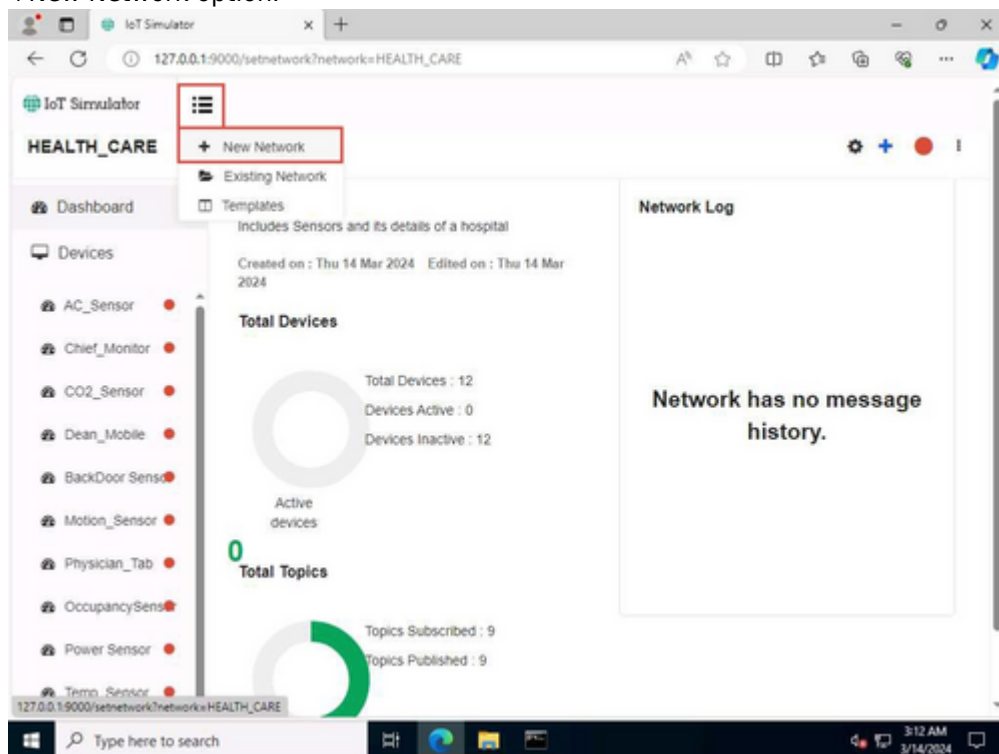
3. To create IoT devices, we must install the IoT simulator on the client machine using Bevywise_IoTSimulator_3.exe



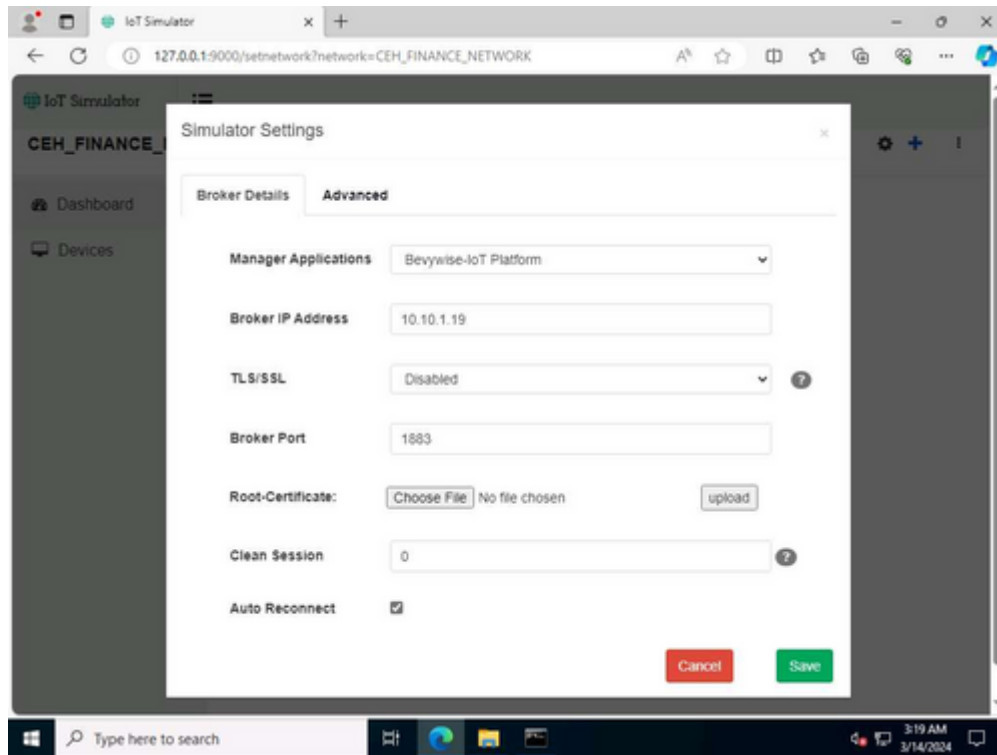
4. Upon double-clicking the runsimulator.bat file opens in the command prompt. If How do you want to open this? pop-up appears, select Microsoft Edge browser and click OK to open the URL http://127.0.0.1:9000/setnetwork?network=HEALTH_CARE.
5. The web interface of the IoT Simulator opens in Edge browser. In the IoT Simulator, you can view the default network named HEALTH_CARE and several devices.



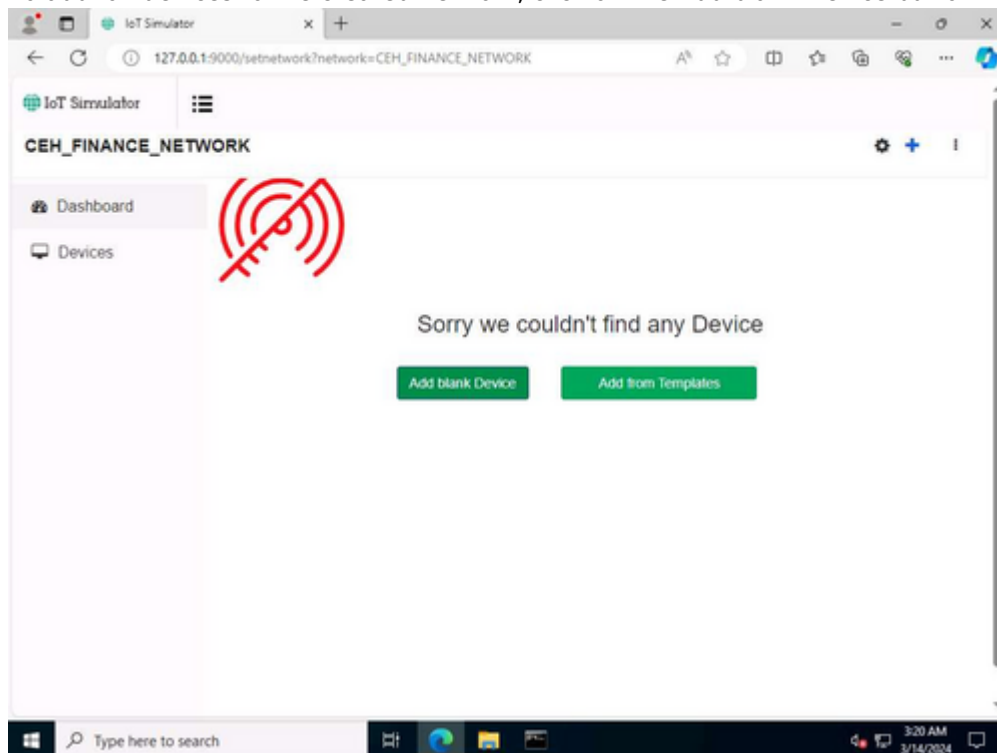
6. Next, we will create a virtual IoT network and virtual IoT devices. Click on the menu icon and select the +New Network option.



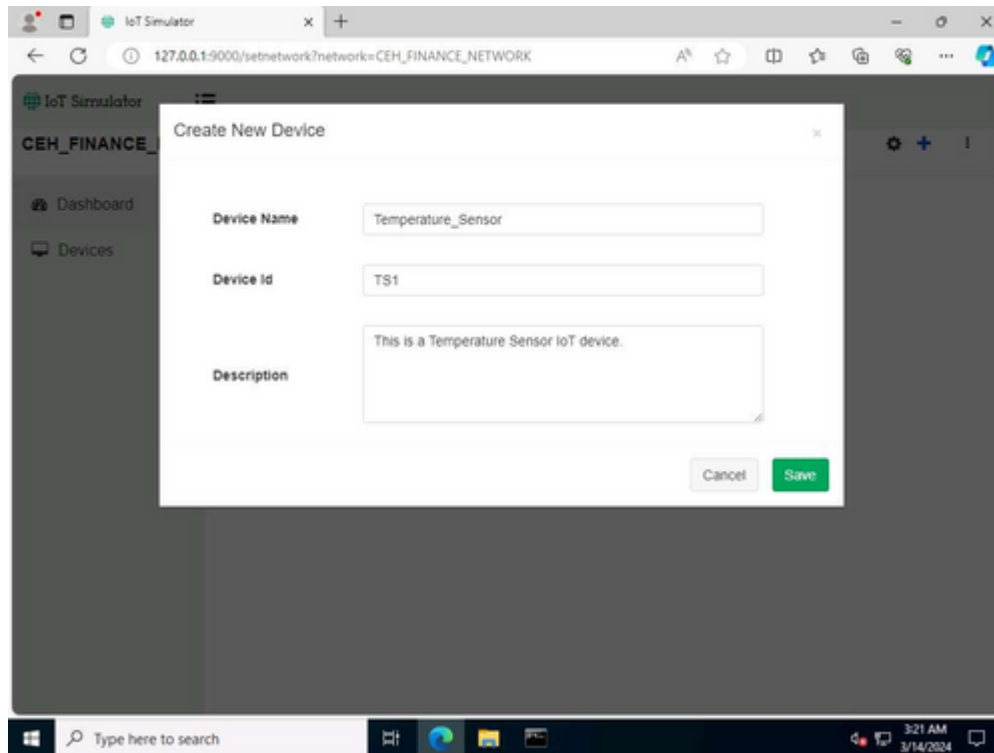
7. The Create New Network popup appears. Type any name (here, CEH_FINANCE_NETWORK) and description. Click on Create.
8. In the next screen, we will setup the Simulator Settings. Set the Broker IP Address as 10.10.1.19 (the IP address of the Windows Server 2019). Since we have installed the Broker on the web server, the created network will interact with the server using MQTT Broker. Do not change default settings and click on Save.



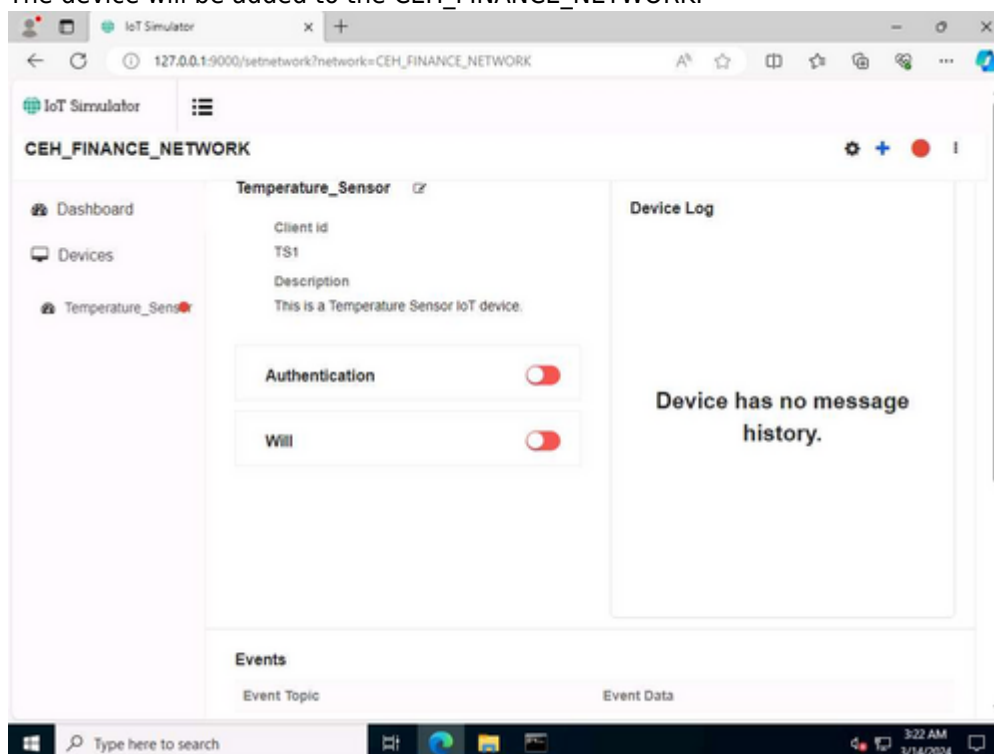
9. To add IoT devices to the created network, click on the Add blank Device button.



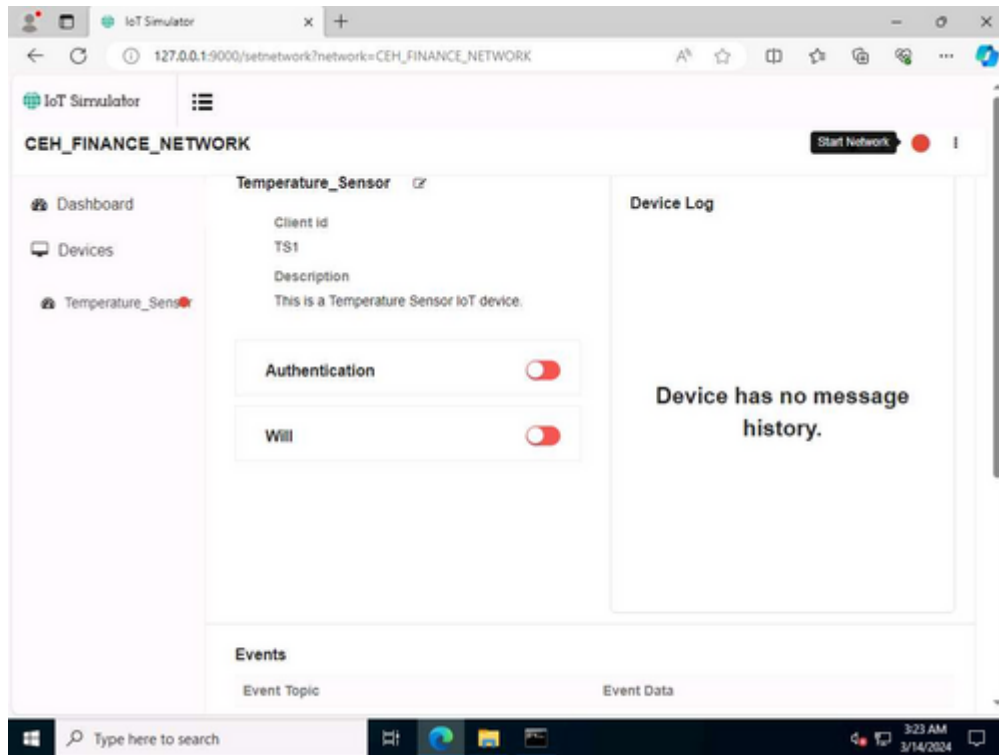
10. The Create New Device popup opens. Type the device name (here, we use Temperature_Sensor), enter Device Id (here, we use TS1), provide a Description and click on Save.



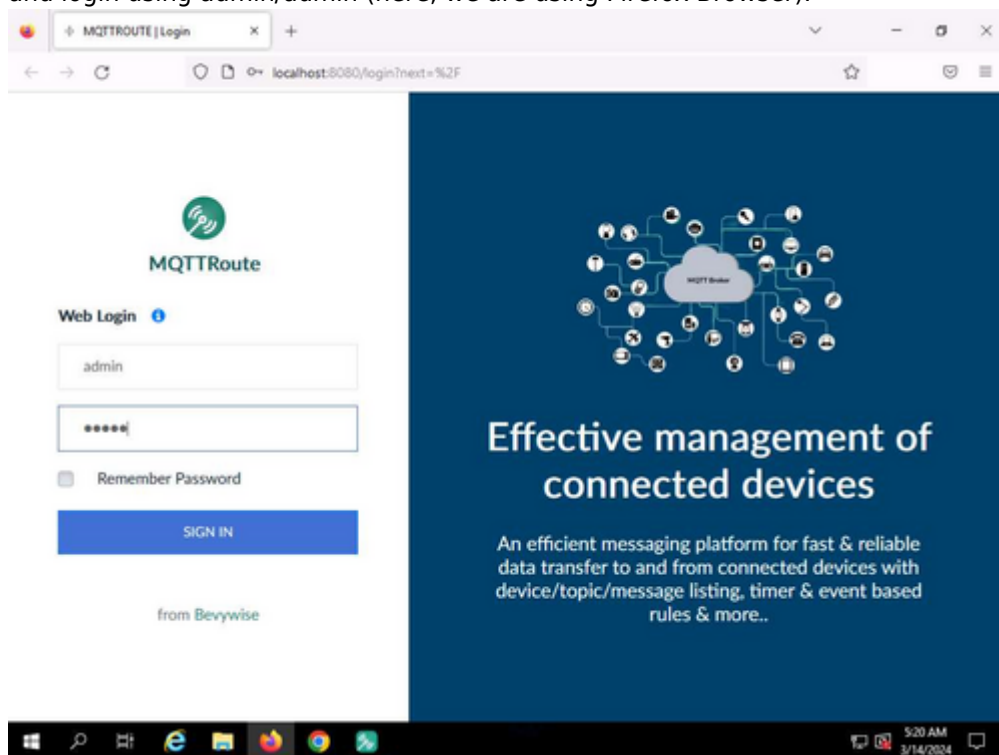
11. The device will be added to the CEH_FINANCE_NETWORK.



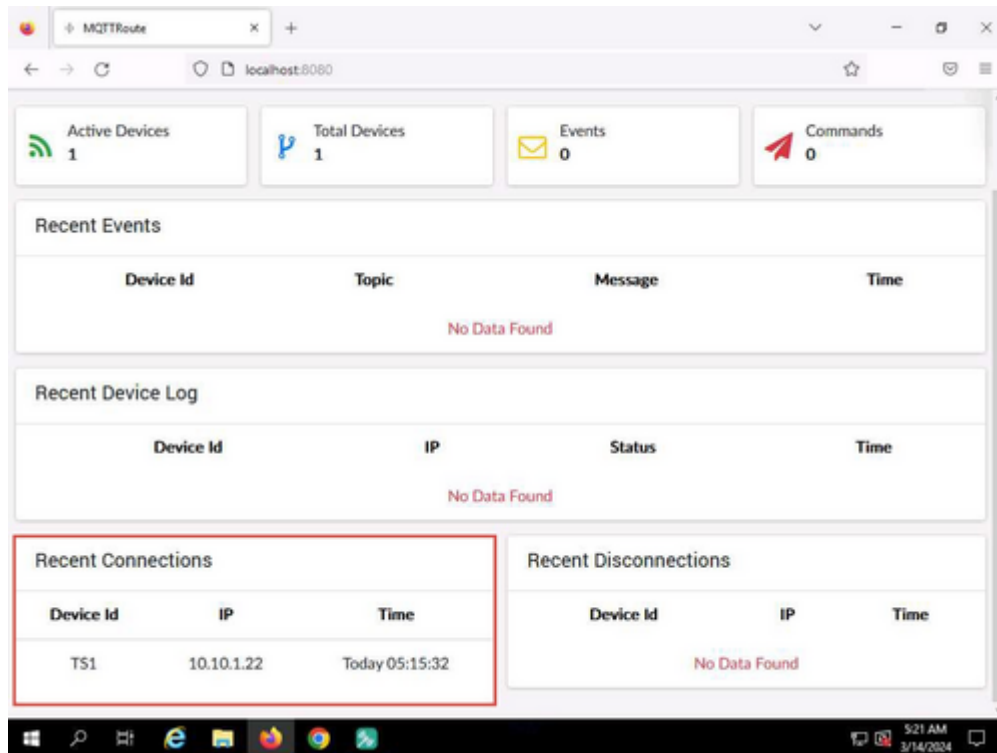
12. To connect the Network and the added devices to the server or Broker, click on the Start Network red color circular icon in right corner.



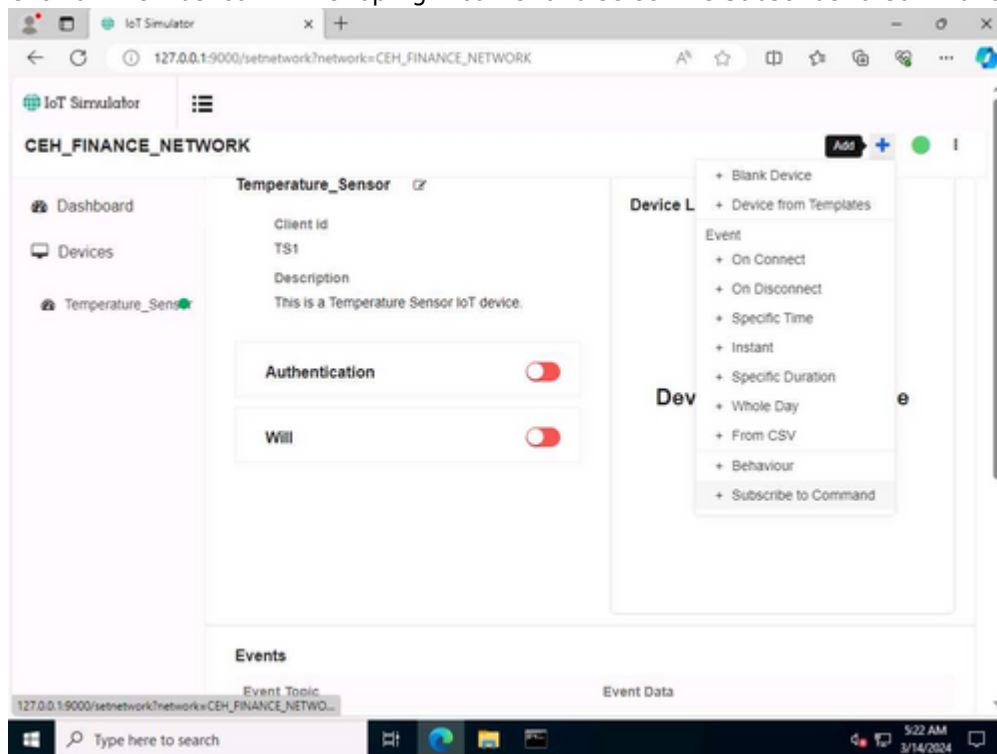
13. When a connection is established between the network and the added devices and the web server or the MQTT Broker, the red button turns into green.
14. Next, switch to the Windows Server 2019 machine. Open a web browser, and go to <http://localhost:8080> and login using admin/admin (here, we are using Firefox Browser).



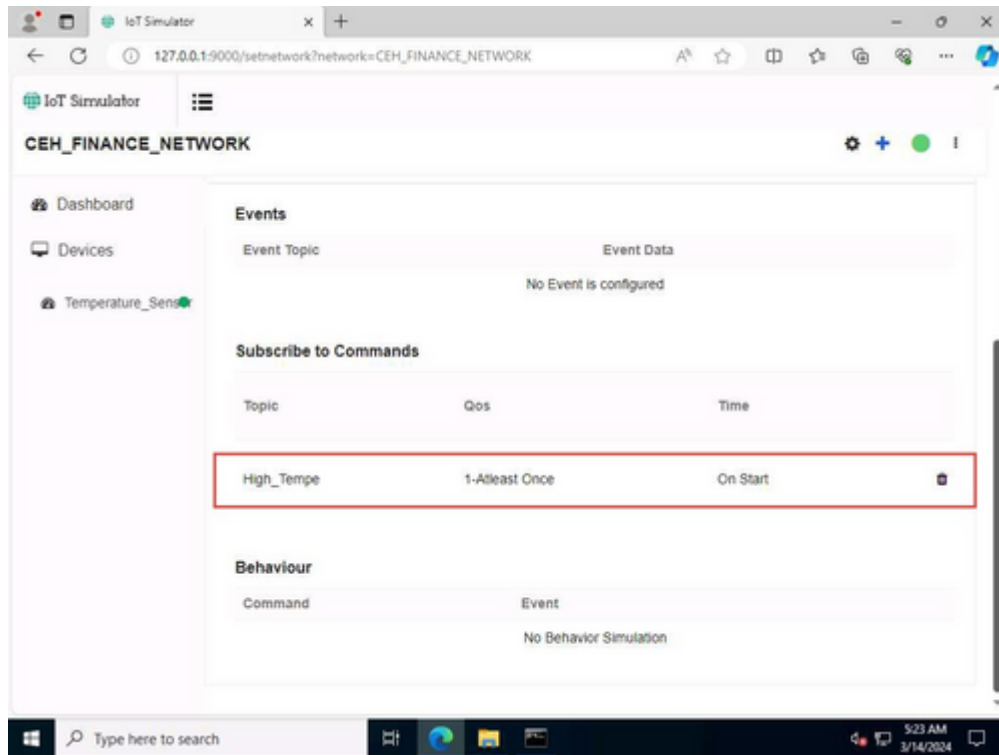
15. Since the Broker was left running, you can see a connection request from machine 10.10.1.22 for the device TS1 under Recent Connections section.



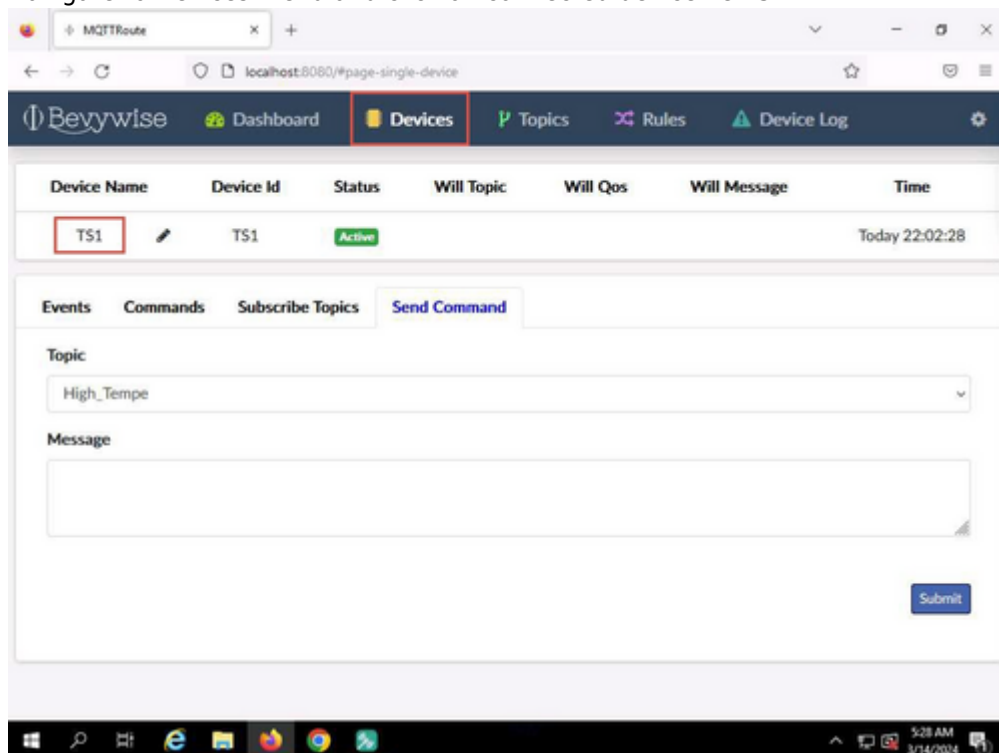
16. Switch back to Windows Server 2022 machine. Next, we will create the Subscribe command for the device Temperature_Sensor.
17. Click on the Plus icon in the top right corner and select the Subscribe to Command option.



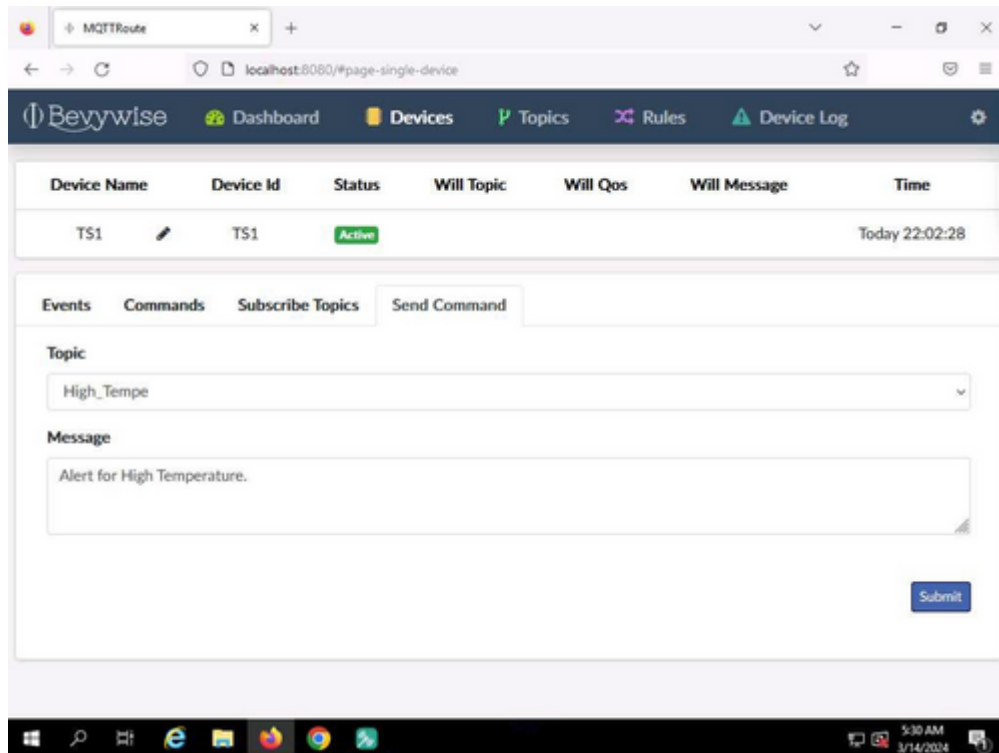
18. The Subscribe for command - TS1 popup opens. Select On start under the Subscribe on tab, type High_Tempe under the Topic tab, and select 1 Atleast once below the Qos option. Click on Save. Scroll down the page, you can see the Topic added under the Subscribe to Commands section.



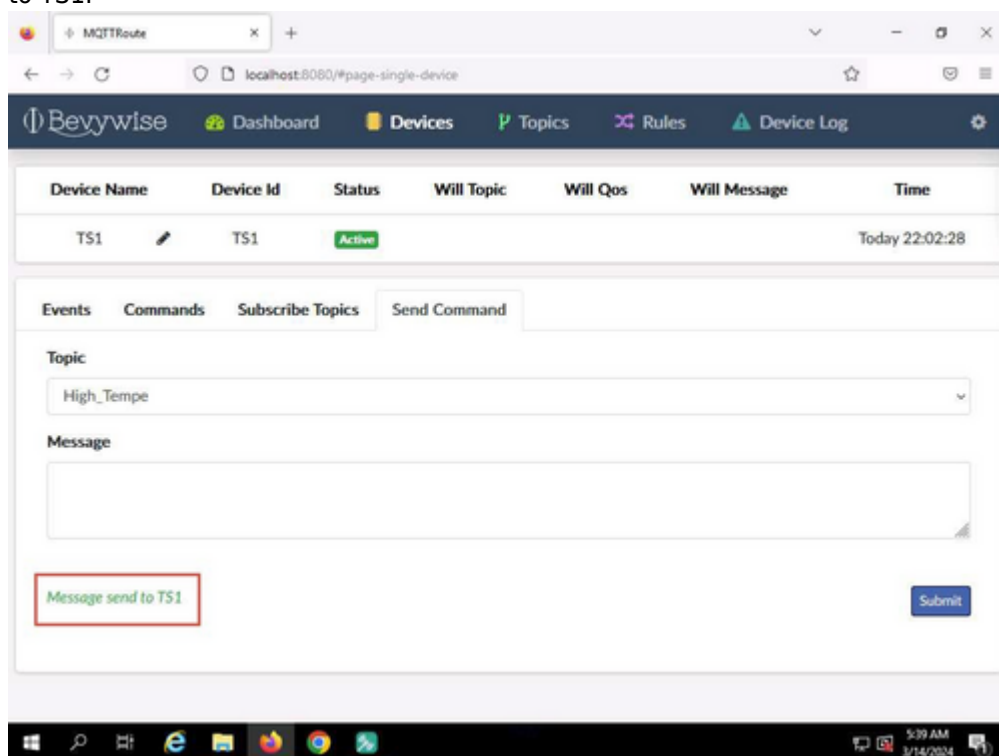
19. Next, we will capture the traffic between the virtual IoT network and the MQTT Broker to monitor the secure communication.
20. Minimise the Edge browser. Click Type here to search field on the Desktop, search for wireshark in the search bar and select Wireshark from the results.
21. The Wireshark Application window appears, select the Ethernet as interface
 1. Make sure you have selected interface which has 10.10.1.22 as the IP address.
22. Click on the Start Wireshark icon to start the capturing packets, leave the Wireshark running.
23. Leave the IoT simulator running and switch to the Windows Server 2019 machine.
24. Navigate to Devices menu and click on connected device i.e.TS1.



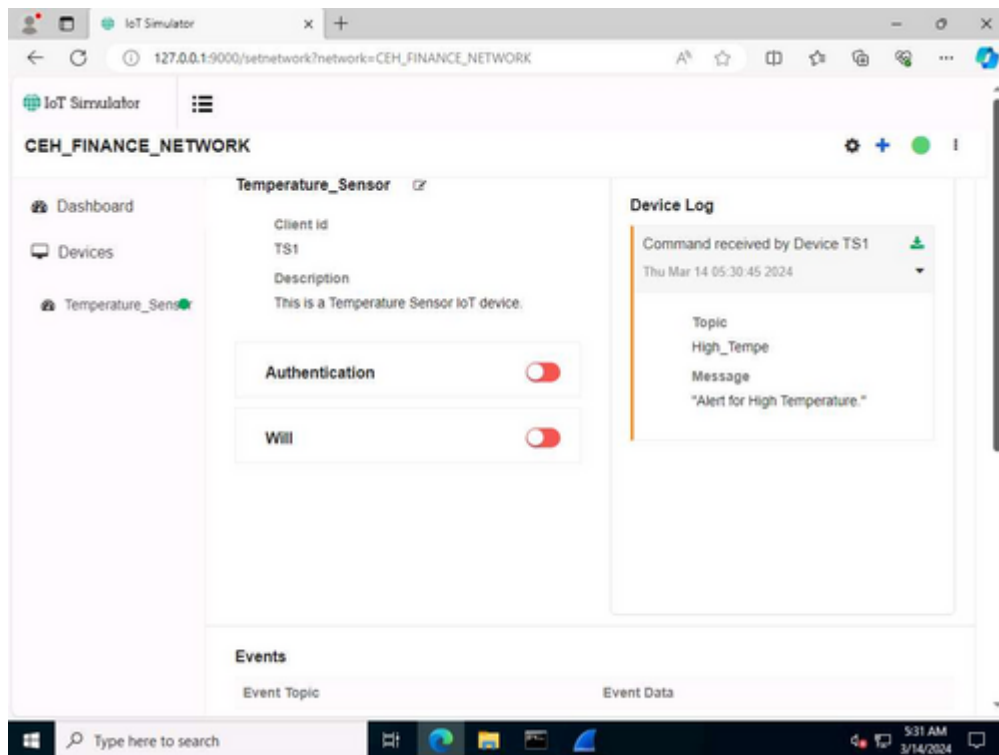
25. Now, we will send the command to TS1 using the High_Tempe topic. In Send Command section, select Topic as High_Tempe, type Alert for High Temperature in Message field and click on the Submit button.



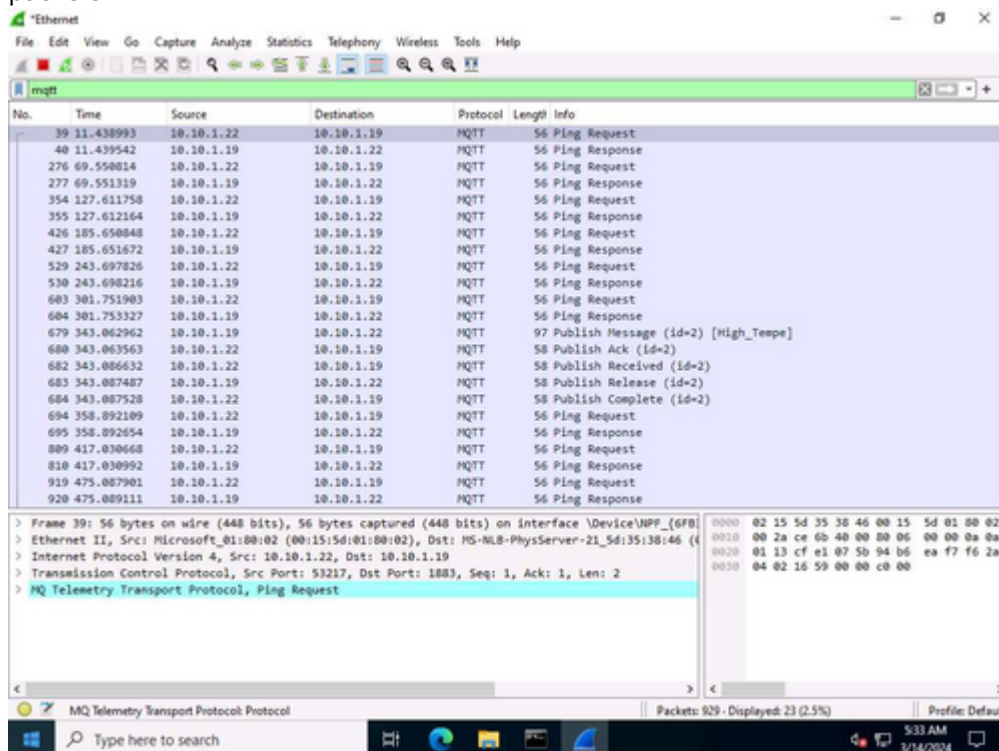
26. Message sent to TS1 appears under Message box which indicates that the message was successfully sent to TS1.



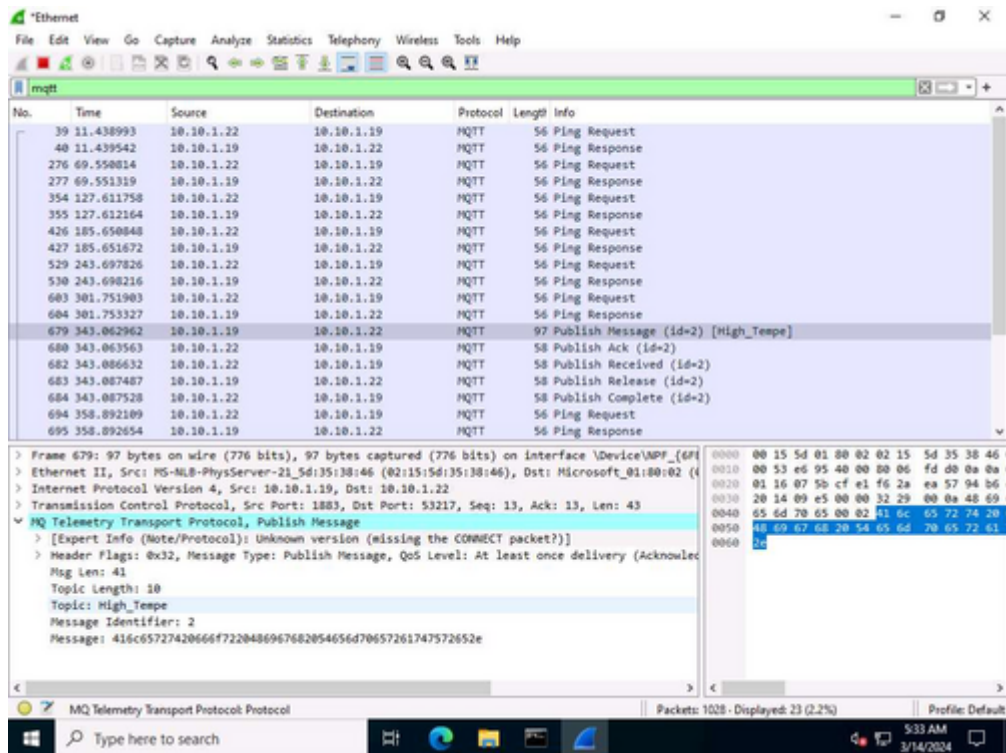
27. Next, switch to Windows Server 2022 machine. We have left the IoT simulator running in the web browser. To see the alert message, maximise the Edge browser and expand the arrow under the connected Temperature_Sensor, Device Log section. You can see the alert message «Alert for High Temperature»



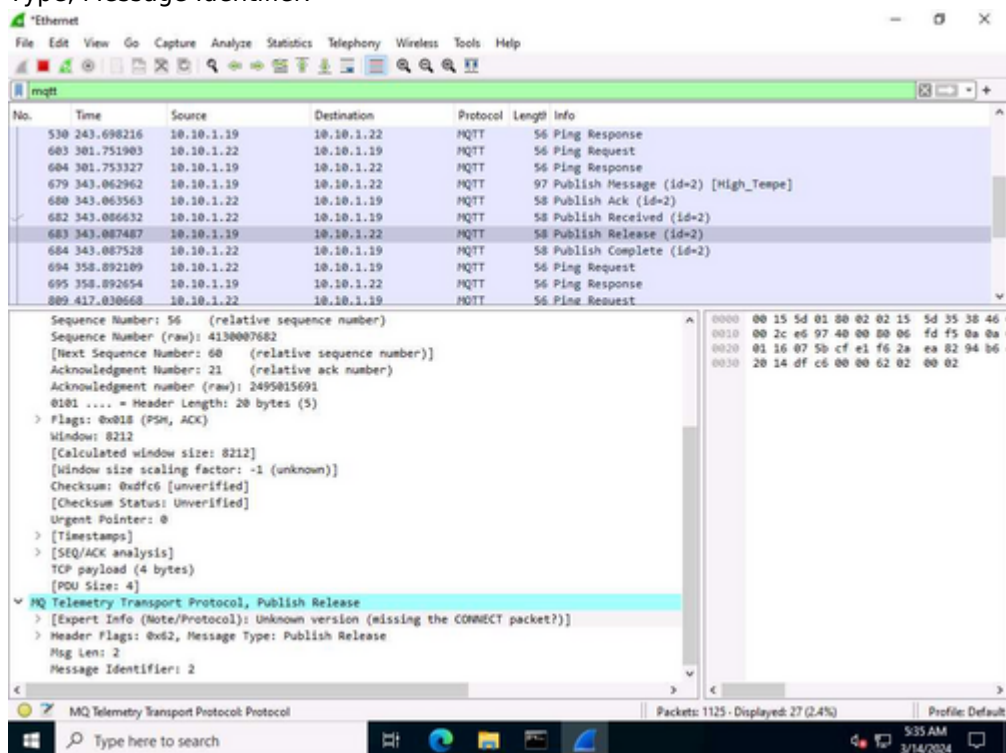
28. To verify the communication, we have executed Wireshark application, switch to the Wireshark traffic capturing window. Type mqtt under the filter field and press Enter. To display only the MQTT protocol packets.



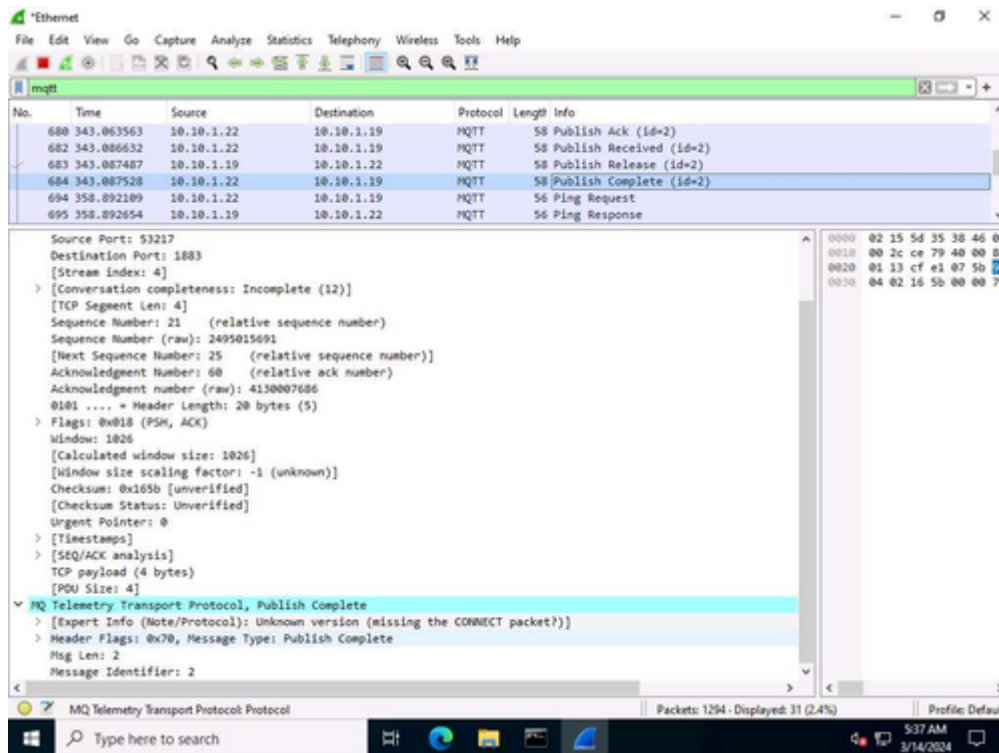
29. Select any Publish Message packet from the Packet List pane. In the Packet Details pane at the middle of the window, expand the Transmission Control Protocol, MQ Telemetry Transport Protocol, and Header Flags nodes.
30. Under the MQ Telemetry Transport Protocol nodes, you can observe details such as Msg Len, Topic Length, Topic, and Message.
31. Publish Message can be used to obtain the message sent by the MQTT client to the broker.



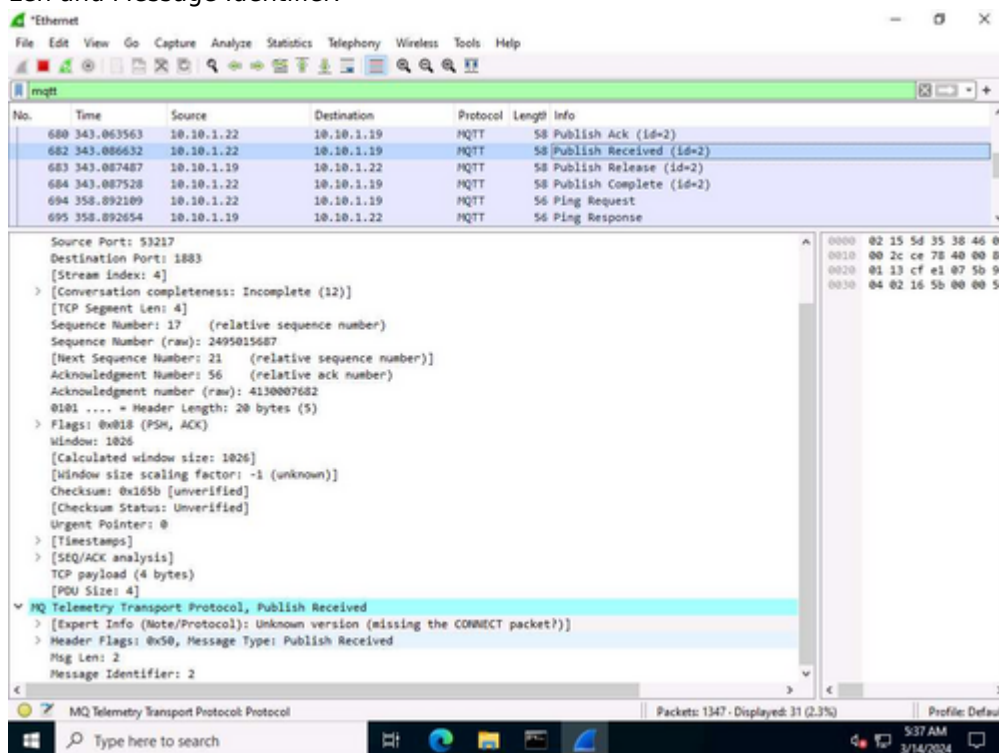
32. Select any Publish Release packet from the Packet List pane. In the Packet Details pane at the middle of the window, expand the Transmission Control Protocol, MQ Telemetry Transport Protocol, and Header Flags nodes.
33. Under the MQ Telemetry Transport Protocol nodes, you can observe details such as Msg Len, Message Type, Message Identifier.



34. Now, scroll down, look for the Publish Complete packet from the Packet List pane, and click on it. In the Packet Details pane at the middle of the window, expand the Transmission Control Protocol, MQ Telemetry Transport Protocol, and Header Flags nodes.
35. Under the MQ Telemetry Transport Protocol nodes, you can observe details such as Msg Len and Message Identifier.



36. Now, scroll down, look for the Publish Received packet from the Packet List pane, and click on it. In the Packet Details pane at the middle of the window, expand the Transmission Control Protocol, MQ Telemetry Transport Protocol, and Header Flags nodes.
37. Under the MQ Telemetry Transport Protocol nodes, you can observe details such as Message Type, Msg Len and Message Identifier.



38. Similarly you can select Ping Request, Ping Response and Publish Ack packets and observe the details.

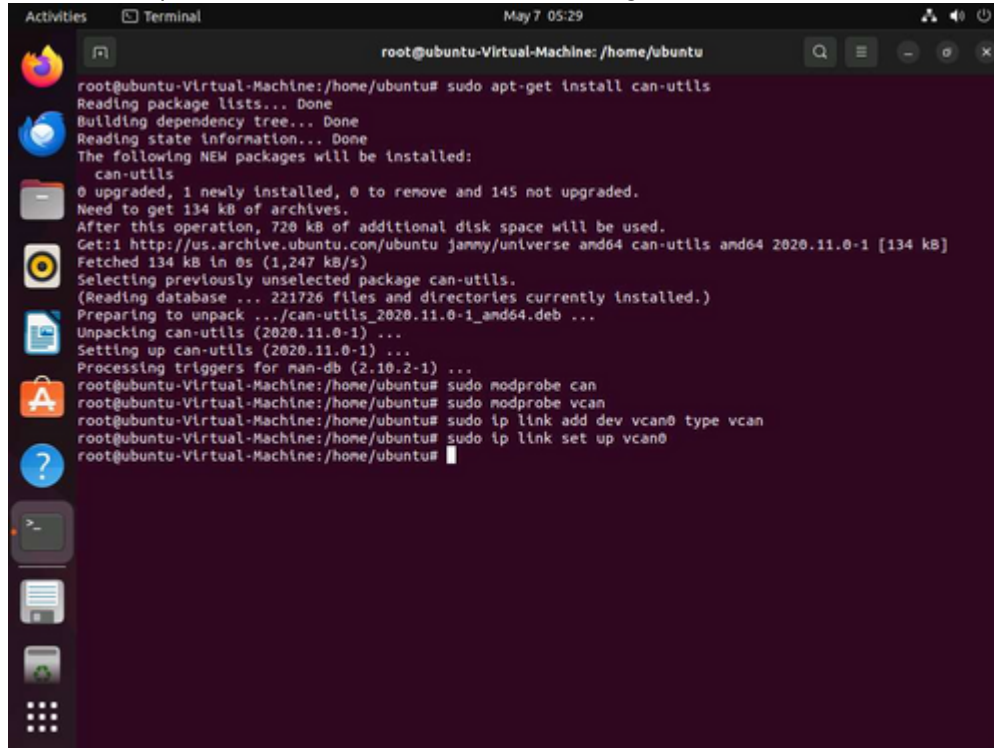
Lab 3: Perform IoT Attacks

Task 1: Perform Replay Attack on CAN Protocol

1. In the Ubuntu machine, open a Terminal window and execute `sudo su` to run the programs as a root user

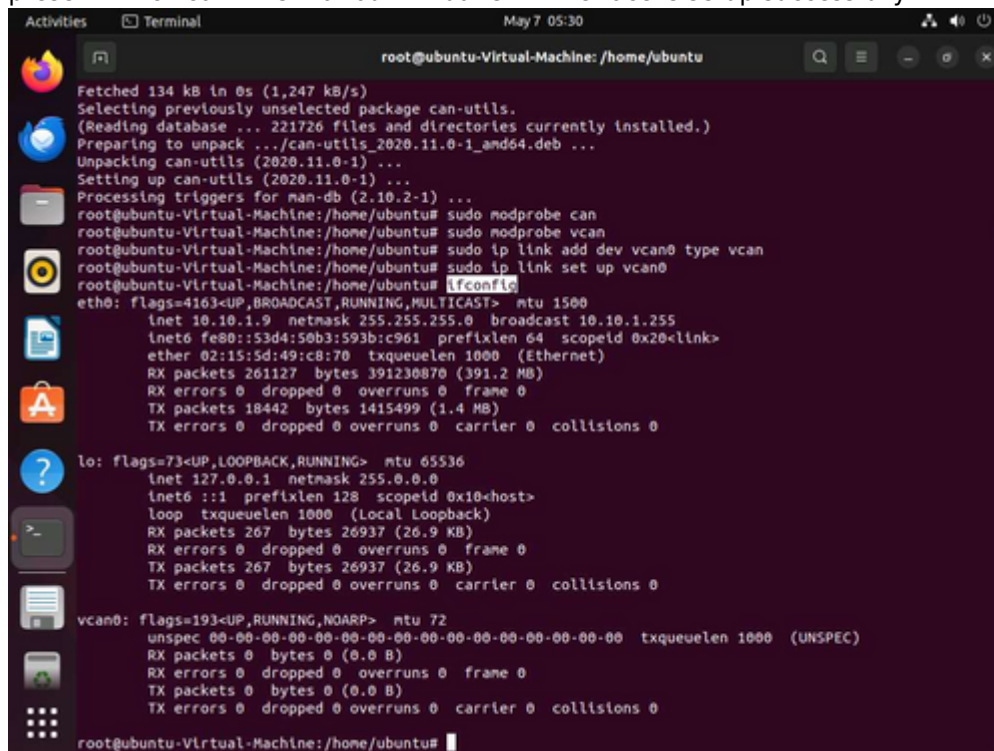
(When prompted, enter the password too).

2. Run **sudo apt-get install can-utils** to install CAN utility
3. Now, to setup a virtual CAN interface issue following commands:



```
root@ubuntu-Virtual-Machine: /home/ubuntu# sudo apt-get install can-utils
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following NEW packages will be installed:
  can-utils
0 upgraded, 1 newly installed, 0 to remove and 145 not upgraded.
Need to get 134 kB of archives.
After this operation, 720 kB of additional disk space will be used.
Get:1 http://us.archive.ubuntu.com/ubuntu jammy/universe amd64 can-utils amd64 2020.11.0-1 [134 kB]
Fetched 134 kB in 0s (1,247 kB/s)
Selecting previously unselected package can-utils.
(Reading database ... 221726 files and directories currently installed.)
Preparing to unpack .../can-utils_2020.11.0-1_amd64.deb ...
Unpacking can-utils (2020.11.0-1) ...
Setting up can-utils (2020.11.0-1) ...
Processing triggers for man-db (2.10.2-1) ...
root@ubuntu-Virtual-Machine: /home/ubuntu# sudo modprobe can
root@ubuntu-Virtual-Machine: /home/ubuntu# sudo modprobe vcan
root@ubuntu-Virtual-Machine: /home/ubuntu# sudo ip link add dev vcan0 type vcan
root@ubuntu-Virtual-Machine: /home/ubuntu# sudo ip link set up vcan0
root@ubuntu-Virtual-Machine: /home/ubuntu#
```

1. **sudo modprobe can**
 2. **sudo modprobe vcan**
 3. **sudo ip link add dev vcan0 type vcan**
 4. **sudo ip link set up vcan0**
4. To check whether Virtual CAN interface is setup successfully, run **ifconfig**. Here, vcan0 interface is present which confirms that our Virtual CAN interface is setup successfully.



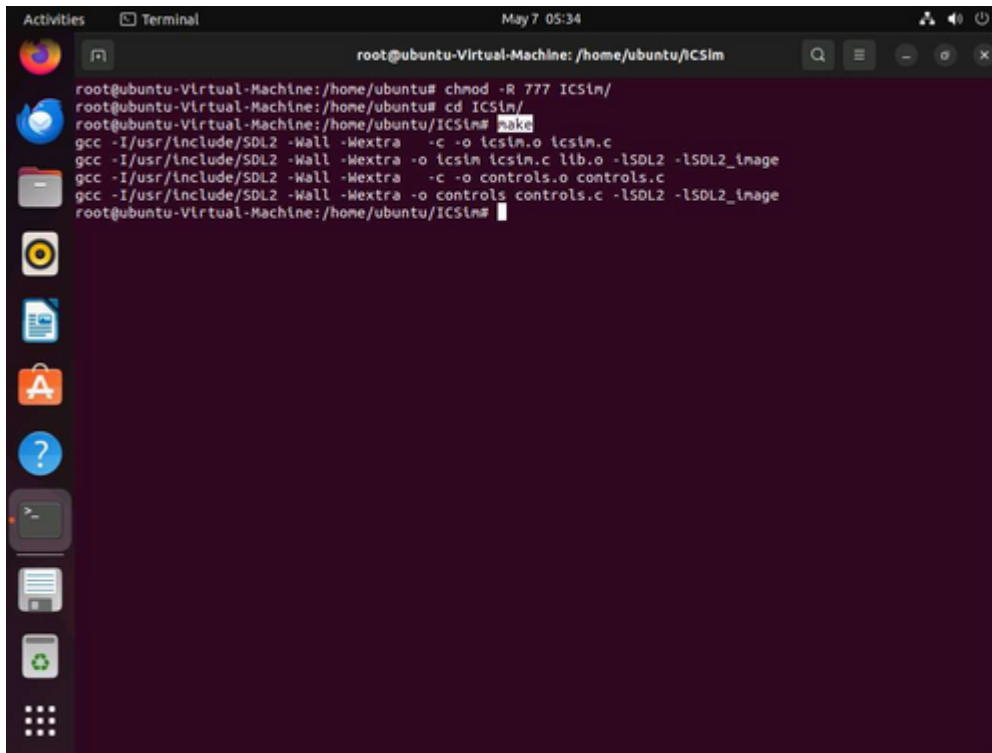
```
root@ubuntu-Virtual-Machine: /home/ubuntu# ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.10.1.9 netmask 255.255.255.0 broadcast 10.10.1.255
    inet6 fe80::53d4:50b3:593b:c961 prefixlen 64 scopeid 0x20<link>
    ether 02:15:5d:49:c8:70 txqueuelen 1000 (Ethernet)
    RX packets 261127 bytes 391230870 (391.2 MB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 18442 bytes 1415499 (1.4 MB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 267 bytes 26937 (26.9 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 267 bytes 26937 (26.9 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

vcan0: flags=193<UP,RUNNING,NOARP> mtu 72
    unspec 00-00-00-00-00-00-00-00-00-00-00-00-00-00-00 txqueuelen 1000 (UNSPEC)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

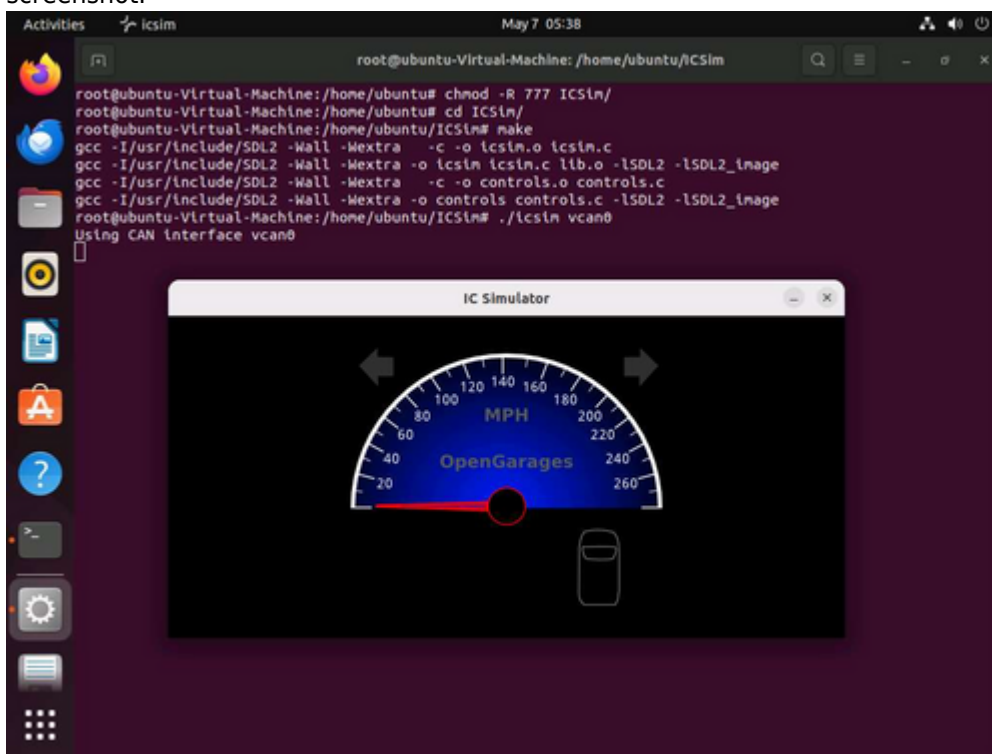
root@ubuntu-Virtual-Machine: /home/ubuntu#
```

5. Run **chmod -R 777 ICSim** to give permissions to the ICSim folder.
6. Now, run **cd ICSim** to navigate to ICSim directory and execute **make** command to create two executable files for IC Simulator and CANBus Control Panel.

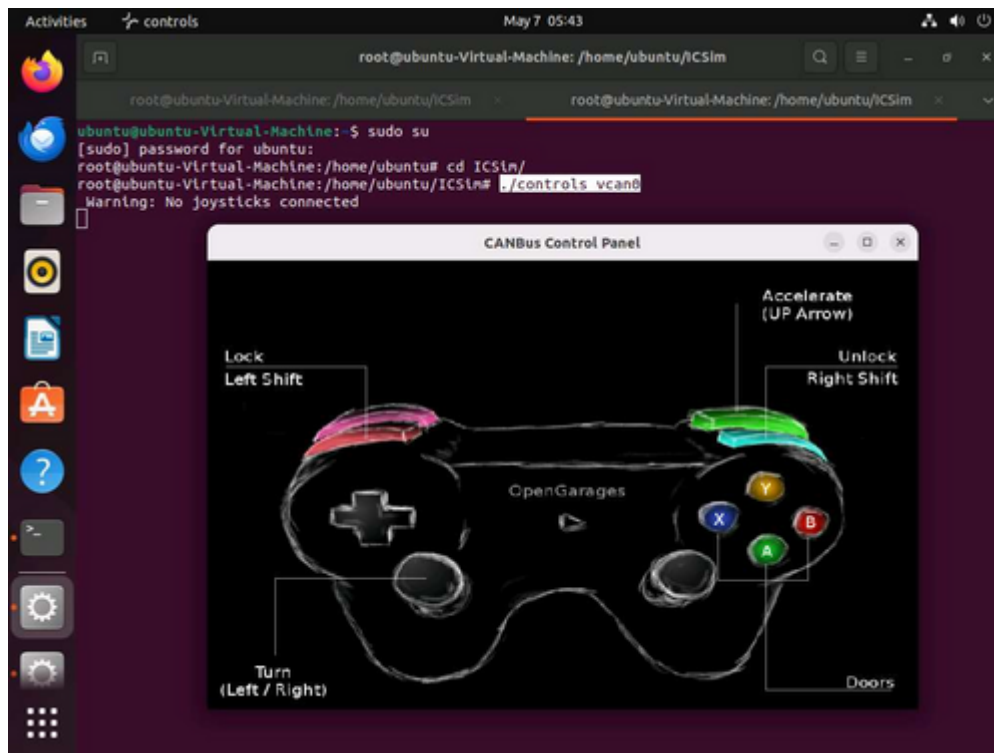


```
root@ubuntu-Virtual-Machine: /home/ubuntu/ICSim
root@ubuntu-Virtual-Machine: /home/ubuntu# chmod -R 777 ICSim/
root@ubuntu-Virtual-Machine: /home/ubuntu# cd ICSim/
root@ubuntu-Virtual-Machine: /home/ubuntu/ICSim# make
gcc -I/usr/include/SDL2 -Wall -Wextra -c -o icsim.o icsim.c
gcc -I/usr/include/SDL2 -Wall -Wextra -o icsim icsim.o lib.o -lSDL2 -lSDL2_image
gcc -I/usr/include/SDL2 -Wall -Wextra -c -o controls.o controls.c
gcc -I/usr/include/SDL2 -Wall -Wextra -o controls controls.o -lSDL2 -lSDL2_image
root@ubuntu-Virtual-Machine: /home/ubuntu/ICSim#
```

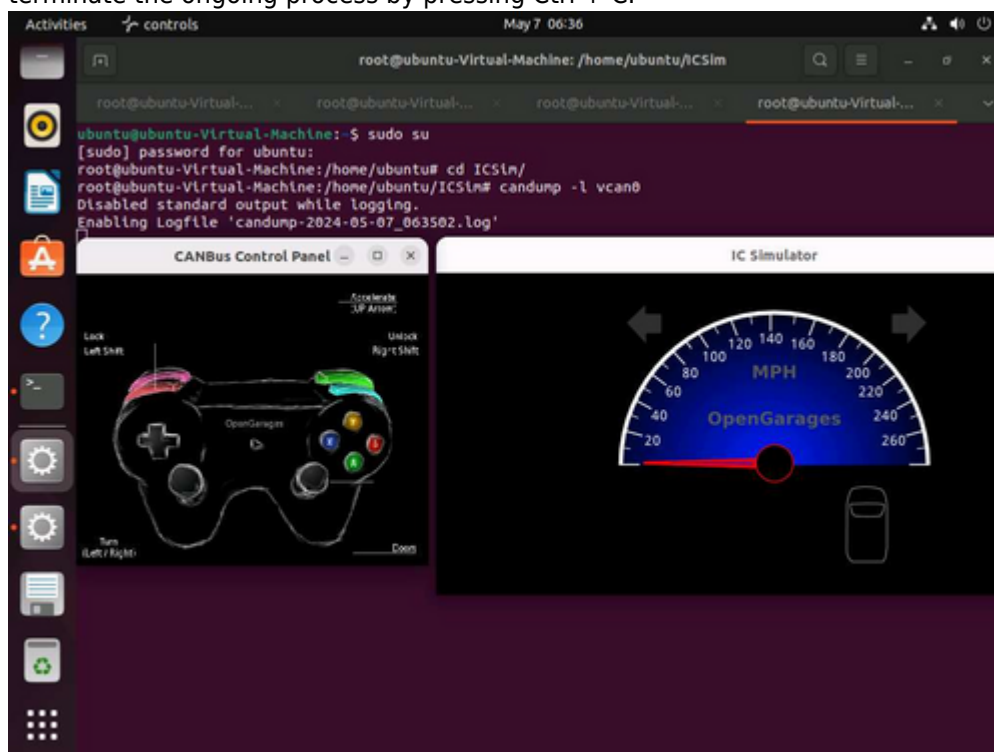
7. Run **./icsim vcan0** to start the ICSim simulator. You will see the IC Simulator interface as shown in the screenshot.



8. Open a new terminal tab and execute **sudo su** to run the programs as a root user (When prompted, enter the password toor). Navigate to ICSim directory to do so run **cd ICSim/**.
9. Execute **./controls vcan0** to start the CANBus Control Panel. You will see the CANBus Control Panel interface as shown in the screenshot.

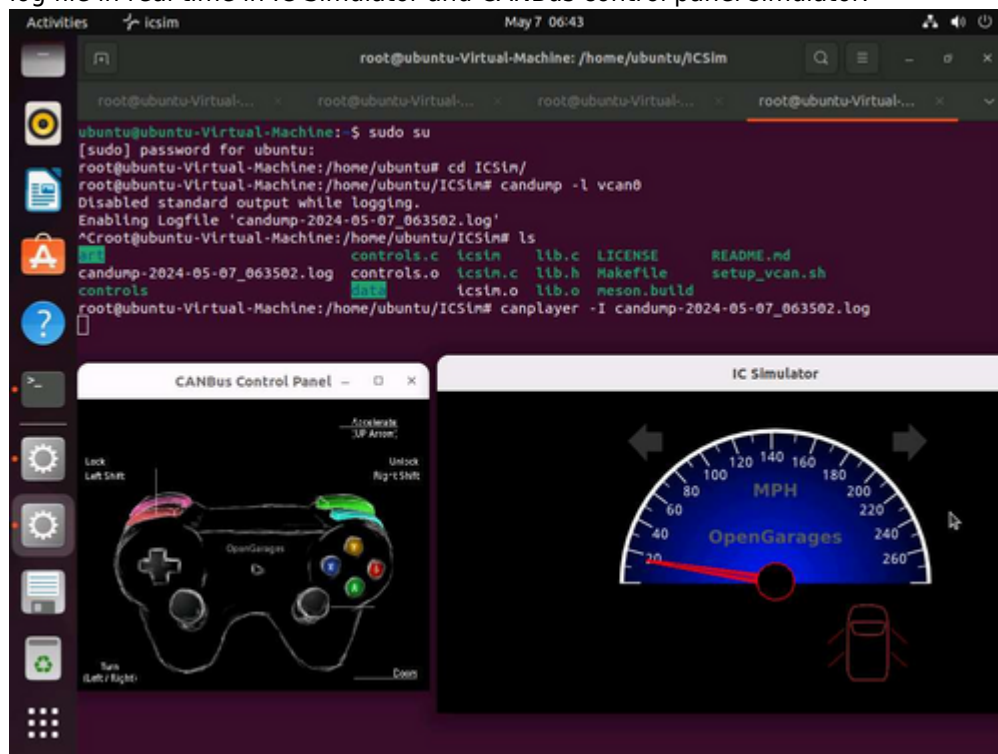


10. Now, we will start sniffer to capture the traffic sent to the ICSim Simulator by CANBus control panel simulator. To do so, open a new terminal tab and execute `sudo su` to run the programs as a root user (When prompted, enter the password toor). Navigate to ICSim directory to do so run `cd ICSim/`.
11. Execute `cansniffer -c vcan0` to start sniffing on the vcan0 interface. Leave this sniffer on.
12. Open a new terminal and execute `sudo su` to run the programs as a root user (When prompted, enter the password toor). Navigate to ICSim directory to do so run `cd ICSim/`. To capture the logs run `candump -l vcan0`.
13. After starting to capture the logs, open ICSim and Controller simulator and perform functions such as acceleration, turning left/right, opening and locking doors so that logs are generated. Once you are done, terminate the ongoing process by pressing `Ctrl + C`.



14. Now verify if you have obtained the log file by executing `ls` command. The .log file has been generated as shown in the screenshot.
15. Now, to perform replay attack, run `canplayer -l candump-2024-05-07_063502.log` and press enter.
 1. Once the log file is executed, you can see the movements that were performed while creating the

log file in real time in IC Simulator and CANBus control panel simulator.



From:

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