Practical 6: To set up MQTT communication using Mosquitto and Node-RED, enabling real-time data exchange and visualization for IoT applications.

6.1 Theory

In IoT applications, efficient and real-time data communication is vital for monitoring, automation, and decision-making. **MQTT (Message Queuing Telemetry Transport)** is a lightweight protocol built on the publish-subscribe model, making it ideal for low-bandwidth and high-latency environments. This practical explores how MQTT communication is implemented using **Mosquitto** as the broker and **Node-RED** for flow-based development and visualization.

🛰️ MQTT Protocol with Mosquitto

MQTT involves three key components:

- **Publisher**: Sends messages to a topic.
- **Subscriber**: Receives messages by subscribing to a topic.
- **Broker**: Manages all message exchanges (Mosquitto in this case).

Mosquitto is an open-source MQTT broker that efficiently handles communication between clients. It ensures message delivery using different Quality of Service (QoS) levels, making it highly reliable for IoT environments.

🔁 Node-RED Integration

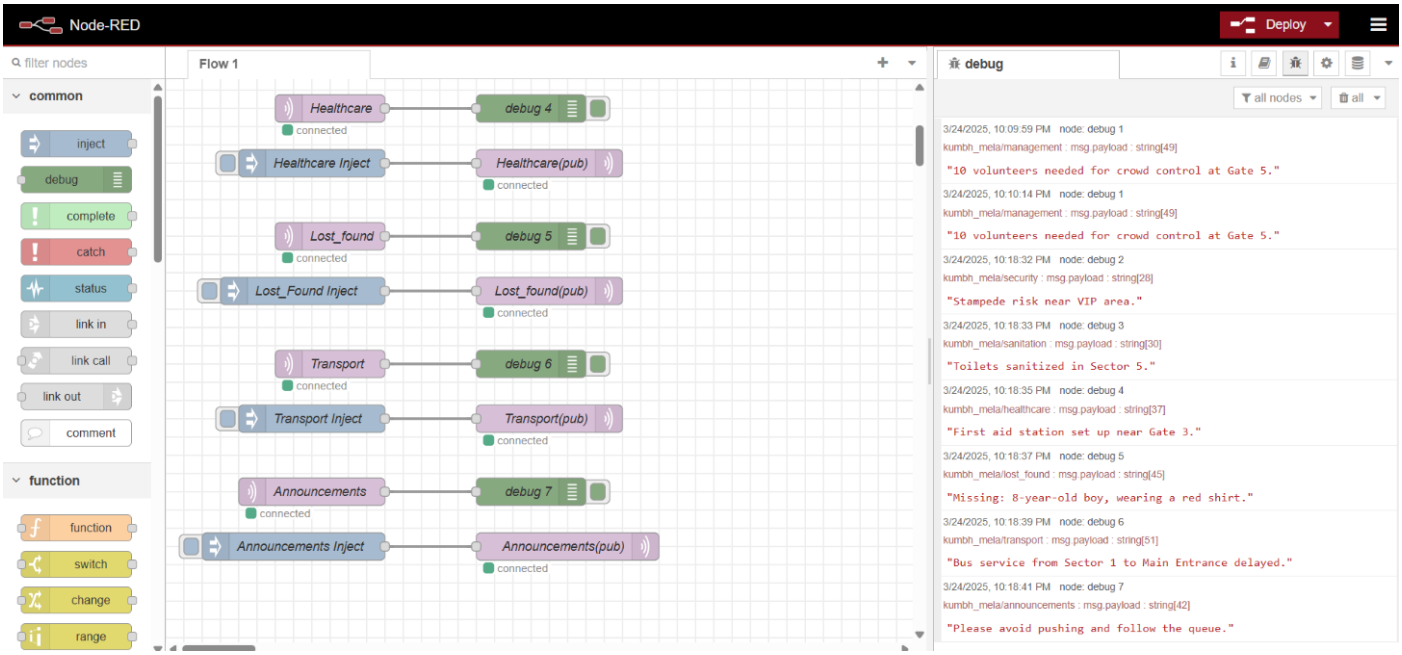
Node-RED is a flow-based programming platform that allows users to visually wire together devices, services, and APIs. It includes built-in nodes for:

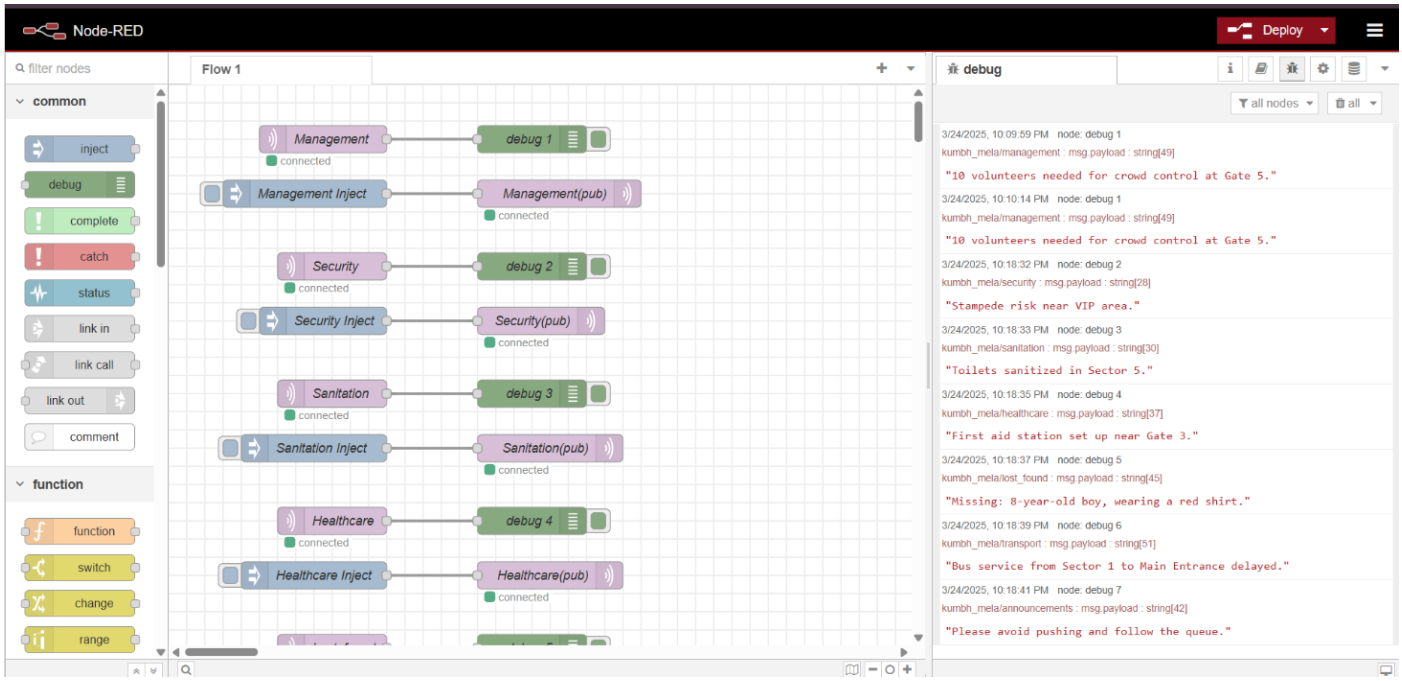
- Publishing and subscribing to MQTT topics.
- Visualizing data using dashboards (charts, gauges, text).
- Executing logic like condition checks, alarms, and cloud integration.

By combining Mosquitto with Node-RED, developers can create a powerful real-time IoT system that is both interactive and easy to monitor.

🌐 Example Use Case

A temperature sensor publishes data to the topic home/sensor/temp. Node-RED subscribes to this topic, shows the reading on a gauge, and triggers an alert if the temperature exceeds a set threshold.


Node-RED
Deploy
filter nodes
Flow 1
debug
common
inject
debug
complete
catch
status
link in
link call
link out
comment
function
function
switch
change
range
Healthcare
connected
debug 4
Healthcare Inject
Healthcare(pub)
connected
Lost_found
connected
debug 5
Lost_Found Inject
Lost_found(pub)
connected
Transport
connected
debug 6
Transport Inject
Transport(pub)
connected
Announcements
connected
debug 7
Announcements Inject
Announcements(pub)
connected
all nodes
all
3/24/2025, 10:09:59 PM node: debug 1
kumbh_mela/management : msg.payload : string[49]
"10 volunteers needed for crowd control at Gate 5."
3/24/2025, 10:10:14 PM node: debug 1
kumbh_mela/management : msg.payload : string[49]
"10 volunteers needed for crowd control at Gate 5."
3/24/2025, 10:18:32 PM node: debug 2
kumbh_mela/security : msg.payload : string[28]
"Stampede risk near VIP area."
3/24/2025, 10:18:33 PM node: debug 3
kumbh_mela/sanitation : msg.payload : string[30]
"Toilets sanitized in Sector 5."
3/24/2025, 10:18:35 PM node: debug 4
kumbh_mela/healthcare : msg.payload : string[37]
"First aid station set up near Gate 3."
3/24/2025, 10:18:37 PM node: debug 5
kumbh_mela/lost_found : msg.payload : string[45]
"Missing: 8-year-old boy, wearing a red shirt."
3/24/2025, 10:18:39 PM node: debug 6
kumbh_mela/transport : msg.payload : string[51]
"Bus service from Sector 1 to Main Entrance delayed."
3/24/2025, 10:18:41 PM node: debug 7
kumbh_mela/announcements : msg.payload : string[42]
"Please avoid pushing and follow the queue."


Node-RED
Deploy
filter nodes
Flow 1
debug
common
inject
debug
complete
catch
status
link in
link call
link out
comment
function
function
switch
change
range
Management
connected
debug 1
Management Inject
Management(pub)
connected
Security
connected
debug 2
Security Inject
Security(pub)
connected
Sanitation
connected
debug 3
Sanitation Inject
Sanitation(pub)
connected
Healthcare
connected
debug 4
Healthcare Inject
Healthcare(pub)
connected
all nodes
all
3/24/2025, 10:09:59 PM node: debug 1
kumbh_mela/management : msg.payload : string[49]
"10 volunteers needed for crowd control at Gate 5."
3/24/2025, 10:10:14 PM node: debug 1
kumbh_mela/management : msg.payload : string[49]
"10 volunteers needed for crowd control at Gate 5."
3/24/2025, 10:18:32 PM node: debug 2
kumbh_mela/security : msg.payload : string[28]
"Stampede risk near VIP area."
3/24/2025, 10:18:33 PM node: debug 3
kumbh_mela/sanitation : msg.payload : string[30]
"Toilets sanitized in Sector 5."
3/24/2025, 10:18:35 PM node: debug 4
kumbh_mela/healthcare : msg.payload : string[37]
"First aid station set up near Gate 3."
3/24/2025, 10:18:37 PM node: debug 5
kumbh_mela/lost_found : msg.payload : string[45]
"Missing: 8-year-old boy, wearing a red shirt."
3/24/2025, 10:18:39 PM node: debug 6
kumbh_mela/transport : msg.payload : string[51]
"Bus service from Sector 1 to Main Entrance delayed."
3/24/2025, 10:18:41 PM node: debug 7
kumbh_mela/announcements : msg.payload : string[42]
"Please avoid pushing and follow the queue."