📘 Internet of Things – Unit 04

IoT Communication Protocols – RGPV Topper-Level Notes

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1. MQTT

Definition

MQTT stands for Message Queuing Telemetry Transport. It is a lightweight messaging protocol used for communication between IoT devices.

Easy Introduction

MQTT IoT devices ke liye specially useful hai because IoT devices low-power aur low-memory wale hote hain. MQTT small data packets send karta hai, isliye fast and efficient hai.

Why This Topic is Important

MQTT IoT communication ka very important protocol hai. RGPV me MQTT, CoAP, AMQP comparison and working frequently expected hote hain.

Detailed Explanation

MQTT **publish-subscribe model** par work karta hai.

Isme 3 main parts hote hain:

Component	Work
Publisher	Data send karta hai
Broker	Messages receive and forward karta hai
Subscriber	Data receive karta hai

Working / Steps

1. Sensor data collect karta hai.
2. Sensor as publisher message broker ko send karta hai.
3. Broker topic ke according message store/forward karta hai.
4. Subscriber us topic ko subscribe karta hai.
5. Subscriber ko message receive hota hai.

Example

Temperature sensor room temperature publish karta hai. Mobile app temperature topic subscribe karti hai.

Diagram / Flowchart

```
Publisher
   ↓
 MQTT Broker
   ↓
Subscriber
```

Detailed:

```
Temperature Sensor → Broker → Mobile App
      publish       topic     subscribe
```

Advantages

- Lightweight
- Low bandwidth required

- Low power devices ke liye suitable
- Reliable messaging
- Remote monitoring ke liye useful

Disadvantages

- Broker fail ho jaye to system affect hota hai
- Security configuration required
- Real-time critical systems ke liye always best nahi

Applications

- Smart home
- Healthcare monitoring
- Agriculture IoT
- Industrial IoT
- Vehicle tracking

Important Keywords for Exam

MQTT, Publisher, Subscriber, Broker, Topic, Lightweight Protocol, Publish-Subscribe Model

Conclusion

MQTT IoT ke liye lightweight and efficient communication protocol hai jo publisher-broker-subscriber model par work karta hai.

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2. MQTT Methods and Components

Definition

MQTT methods are control messages used to establish connection, publish data, subscribe topics and disconnect from MQTT broker.

Main MQTT Components

Component	Meaning
Publisher	Message send karta hai
Subscriber	Message receive karta hai
Broker	Message distribute karta hai
Topic	Message category/path
Client	Publisher ya subscriber device

Important MQTT Methods

Method	Work
CONNECT	Broker se connection start
CONNACK	Connection accepted response
PUBLISH	Message send
SUBSCRIBE	Topic subscribe
SUBACK	Subscribe confirmation
UNSUBSCRIBE	Subscription remove
PINGREQ	Connection alive check
DISCONNECT	Connection close

Flow

```
CONNECT
   ↓
SUBSCRIBE / PUBLISH
   ↓
MESSAGE TRANSFER
```

```
    ↓
DISCONNECT
```

Example

Smart fan app “home/fan/status” topic subscribe karti hai. Fan controller status publish karta hai.

Important Keywords

CONNECT, PUBLISH, SUBSCRIBE, Topic, Broker, Client

Conclusion

MQTT methods communication ko control karte hain and components message transfer possible banate hain.

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3. MQTT Communication, Topics and Applications

Definition

MQTT communication is topic-based message exchange between IoT clients through a broker.

Easy Introduction

MQTT me message direct device-to-device nahi jata. Message broker ke through jata hai.

MQTT Topic

Topic ek address/path hota hai jisme message publish hota hai.

Example:

```
home/room1/temperature
home/kitchen/gas
farm/soil/moisture
```

Working

```
Publisher publishes message on topic
        ↓
Broker checks topic
        ↓
Subscriber receives message
```

Diagram

```
Sensor publishes: home/temp
        ↓
MQTT Broker
        ↓
Mobile App subscribed to: home/temp
```

Applications

- Temperature monitoring
- Smart agriculture
- Smart meter
- Healthcare wearable

- Vehicle tracking

Advantages

- Topic-based filtering
- Many subscribers possible
- Efficient communication

Disadvantages

- Broker dependency
- Topic management required

Important Keywords

Topic, Publish, Subscribe, Broker, IoT Messaging

Conclusion

MQTT topic-based communication makes IoT data exchange simple, scalable and efficient.

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4. SMQTT

Definition

SMQTT stands for Secure MQTT. It is an extension of MQTT that provides security features for IoT communication.

Easy Introduction

Normal MQTT lightweight hota hai but security weak ho sakti hai. SMQTT MQTT communication ko secure banata hai.

Why It Is Needed

IoT data sensitive ho sakta hai, jaise health data, smart home data, industrial data. Security ke liye SMQTT use hota hai.

Detailed Explanation

SMQTT security provide karta hai using:

- encryption
- authentication
- secure key management
- secure message transmission

Working

1. Client broker se secure connection banata hai.
2. Authentication hoti hai.
3. Data encrypt hota hai.
4. Secure message broker ke through send hota hai.
5. Subscriber decrypt karke message read karta hai.

Flow

```
Client Authentication
        ↓
Message Encryption
        ↓
Secure Broker Transfer
        ↓
Message Decryption
```

Diagram

```
Publisher → Encrypted Message → Broker → Subscriber
```

Advantages

- Secure communication
- Data privacy
- Protection from attacks
- Suitable for sensitive IoT systems

Disadvantages

- More processing required
- More power consumption
- Implementation complex

Applications

- Healthcare IoT
- Smart banking
- Industrial IoT
- Smart home security

Important Keywords

Secure MQTT, Encryption, Authentication, Data Privacy, Secure Communication

Conclusion

SMQTT MQTT ko secure banata hai and sensitive IoT communication ke liye useful hai.

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5. CoAP

Definition

CoAP stands for Constrained Application Protocol. It is a lightweight web transfer protocol designed for constrained IoT devices.

Easy Introduction

CoAP small IoT devices ke liye HTTP jaisa protocol hai. Ye low-power devices ke liye lightweight communication provide karta hai.

Why It Is Needed

IoT devices ke paas limited memory, battery and processing power hoti hai. CoAP unke liye simple and low-overhead protocol provide karta hai.

Detailed Explanation

CoAP request-response model par kaam karta hai.

Client request bhejta hai, server response deta hai.

Working / Steps

1. Client request send karta hai.
2. Server request receive karta hai.
3. Server resource process karta hai.
4. Server response send karta hai.

Flow

```
Client → Request → Server
Client ← Response ← Server
```

Diagram

```
Mobile App → GET temperature → Sensor Device
Mobile App ← 30°C response ← Sensor Device
```

Advantages

- Lightweight
- Low power devices ke liye suitable
- REST style communication
- UDP based, fast

Disadvantages

- UDP reliability issue
- Security setup required
- Limited for complex applications

Applications

- Smart lighting
- Smart meters
- Sensor networks
- Home automation

Important Keywords

CoAP, Constrained Device, Request-Response, REST, UDP, Lightweight

Conclusion

CoAP constrained IoT devices ke liye lightweight request-response communication protocol hai.

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6. CoAP Message Types

Definition

CoAP message types define how messages are transferred between client and server.

Types of CoAP Messages

Message Type	Meaning
Confirmable	Acknowledgement required
Non-confirmable	Acknowledgement not required
Acknowledgement	Confirms message received
Reset	Message received but not processed

Easy Explanation

1. Confirmable Message

Important message hota hai. Receiver ko ACK send karna padta hai.

2. Non-confirmable Message

Less important message. ACK required nahi.

3. Acknowledgement

Receiver bolta hai: “Message mil gaya.”

4. Reset

Receiver bolta hai: “Message samajh nahi aaya ya process nahi hua.”

Diagram

```
Confirmable:
Client → CON Message → Server
Client ← ACK ← Server

Non-confirmable:
Client → NON Message → Server
```

Important Keywords

Confirmable, Non-confirmable, ACK, Reset, Reliability

Conclusion

CoAP message types communication reliability manage karte hain.

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7. CoAP Request-Response Model

Definition

CoAP request-response model is a communication model where client sends request and server returns response.

CoAP Methods

Method	Work
GET	Data read
POST	Data create/send
PUT	Data update
DELETE	Data remove

Example

```
GET /temperature
Response: 28°C
```

Flow

```
Client Request
       ↓
Server Processing
       ↓
Server Response
```

Diagram

```
Client → GET /light/status → Server
Client ← ON ← Server
```

Advantages

- Simple model
- REST-like
- Easy for IoT devices
- Low overhead

Important Keywords

GET, POST, PUT, DELETE, Client, Server, REST

Conclusion

CoAP request-response model IoT devices ke liye simple web-like communication provide karta hai.

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8. XMPP

Definition

XMPP stands for Extensible Messaging and Presence Protocol. It is a communication protocol used for real-time message exchange.

Easy Introduction

XMPP originally chat/messaging ke liye bana tha, but IoT me real-time communication ke liye use ho sakta hai.

Why It Is Needed

IoT systems me real-time notifications, device status and alerts ke liye XMPP useful hai.

Working

1. Device XMPP server se connect hota hai.

2. Device message send karta hai.
3. Server message receiver ko forward karta hai.
4. Receiver real-time update paata hai.

Flow

```
IoT Device → XMPP Server → User / Device
```

Diagram

```
Sensor Alert → XMPP Server → Mobile App
```

Advantages

- Real-time messaging
- Presence information
- Secure communication possible
- Extensible protocol

Disadvantages

- More overhead than MQTT/CoAP
- Resource-constrained devices ke liye heavy ho sakta hai

Applications

- Real-time alerts
- Messaging systems
- Smart home notifications

- Device status updates

Important Keywords

XMPP, Real-time Messaging, Presence, Extensible, Alerts

Conclusion

XMPP IoT me real-time messaging and notification ke liye useful protocol hai.

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9. AMQP

Definition

AMQP stands for Advanced Message Queuing Protocol. It is a reliable messaging protocol used for message-oriented middleware.

Easy Introduction

AMQP reliable and secure message transfer ke liye use hota hai. Ye enterprise-level IoT and business systems me useful hai.

Why It Is Needed

Large systems me reliable message delivery important hoti hai. AMQP ensures message lost na ho.

AMQP Features

Feature	Meaning
Reliability	Message safe deliver
Queuing	Messages queue me store

Feature	Meaning
Routing	Message correct receiver tak
Security	Secure communication
Interoperability	Different systems work together

Components

Component	Work
Producer	Message create karta hai
Exchange	Message route karta hai
Queue	Message store karta hai
Consumer	Message receive karta hai
Broker	Complete messaging system manage karta hai

Working

1. Producer message send karta hai.
2. Broker message receive karta hai.
3. Exchange message route karta hai.
4. Queue message store karti hai.
5. Consumer message receive karta hai.

Flow

```
Producer → Exchange → Queue → Consumer
```

Diagram

```
Producer
   ↓
Exchange
   ↓
Queue
   ↓
Consumer
```

Advantages

- Reliable messaging
- Secure
- Message queuing support
- Enterprise systems ke liye suitable

Disadvantages

- MQTT/CoAP se heavy
- More bandwidth required
- Complex setup

Applications

- Banking systems
- Enterprise IoT
- Industrial systems
- Cloud messaging

Important Keywords

AMQP, Producer, Exchange, Queue, Consumer, Broker, Reliable Messaging

Conclusion

AMQP reliable and secure messaging ke liye powerful protocol hai, especially enterprise IoT systems me.

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10. AMQP Frame Types

Definition

AMQP frame types are structured units used to transfer different kinds of information in AMQP communication.

Main Frame Types

Frame Type	Work
Method Frame	Commands carry karta hai
Header Frame	Message properties carry karta hai
Body Frame	Actual message data
Heartbeat Frame	Connection alive check

Easy Explanation

AMQP message ek packet jaisa hota hai jisme command, header, body and heartbeat information hoti hai.

Diagram

```
AMQP Message
   |
Method Frame
Header Frame
Body Frame
Heartbeat Frame
```

Working

1. Method frame command send karta hai.
2. Header frame message details send karta hai.
3. Body frame actual data send karta hai.
4. Heartbeat frame connection active check karta hai.

Advantages

- Structured communication
- Reliable message transfer
- Connection monitoring possible

Important Keywords

Method Frame, Header Frame, Body Frame, Heartbeat Frame

Conclusion

AMQP frame types message communication ko structured and reliable banate hain.

🔥 Comparison Table: MQTT vs CoAP vs XMPP vs AMQP

Basis	MQTT	CoAP	XMPP	AMQP
Model	Publish-subscribe	Request-response	Messaging/presence	Message queuing
Transport	TCP	UDP	TCP	TCP
Weight	Lightweight	Very lightweight	Medium/heavy	Heavy

Basis	MQTT	CoAP	XMPP	AMQP
Best For	Sensor updates	Constrained devices	Real-time alerts	Enterprise messaging
Main Component	Broker	Client-server	XMPP server	Broker/exchange/queue
Reliability	Good	Depends on message type	Good	Very high
IoT Suitability	Very high	Very high	Medium	Medium

Which is Better and Why?

- **MQTT** is best for continuous IoT sensor data.
- **CoAP** is best for small constrained devices.
- **XMPP** is best for real-time alerts.
- **AMQP** is best for reliable enterprise messaging.

For most IoT exam answers, write:

MQTT and CoAP are most suitable for IoT because they are lightweight.

🔥 MOST IMPORTANT TOPICS

1. MQTT ⭐⭐⭐⭐⭐
2. CoAP ⭐⭐⭐⭐⭐
3. MQTT vs CoAP ⭐⭐⭐⭐⭐
4. AMQP ⭐⭐⭐⭐
5. CoAP Message Types ⭐⭐⭐⭐
6. MQTT Components ⭐⭐⭐⭐
7. XMPP ⭐⭐⭐
8. SMQTT ⭐⭐⭐
9. AMQP Frame Types ⭐⭐⭐

⭐ MOST IMPORTANT 7-MARK QUESTIONS

1. Explain MQTT and its components.
2. Explain MQTT publish-subscribe model.
3. Explain CoAP and its request-response model.
4. Explain CoAP message types.
5. Differentiate between MQTT and CoAP.
6. Explain XMPP.
7. Explain AMQP features and components.
8. Explain AMQP frame types.
9. Explain SMQTT.

⭐ MOST IMPORTANT 14-MARK QUESTIONS

1. Explain MQTT protocol with methods, components and applications.
2. Explain CoAP with message types and request-response model.
3. Compare MQTT, CoAP, XMPP and AMQP.
4. Explain AMQP features, components and frame types.
5. Explain IoT communication protocols in detail.

🎯 PYQ-BASED EXPECTED QUESTIONS

Very High Probability

✅ MQTT
✅ CoAP

✅ MQTT vs CoAP

✅ MQTT publish-subscribe model

High Probability

✅ CoAP message types

✅ AMQP features and components

✅ XMPP

Medium Probability

✅ SMQTT

✅ AMQP frame types

✅ MQTT topics and methods

⚡ ONE-NIGHT REVISION NOTES

Topic	Quick Revision
MQTT	Publish-subscribe lightweight protocol
Broker	Message distributor
Topic	Message category/path
CoAP	Lightweight request-response protocol
XMPP	Real-time messaging protocol
AMQP	Reliable message queuing protocol
SMQTT	Secure MQTT
ACK	Message received confirmation
Heartbeat	Connection alive checking

📌 SMART STUDY PLAN

2-Hour Revision Strategy

Time	Topic
30 min	MQTT
30 min	CoAP
20 min	MQTT vs CoAP
20 min	AMQP
10 min	XMPP
10 min	SMQTT + Frame types

5-Hour Strategy

Time	Topic
1 hour	MQTT full
1 hour	CoAP full
1 hour	AMQP
45 min	XMPP + SMQTT
45 min	Comparison + PYQ revision
30 min	Diagrams practice

One-Night Priority Order

1. MQTT
2. CoAP
3. MQTT vs CoAP
4. AMQP
5. CoAP message types
6. XMPP
7. SMQTT
8. AMQP frames

🧠 MEMORY TRICKS

MQTT Model

PBS

- P = Publisher
- B = Broker
- S = Subscriber

CoAP Methods

GPUD

- G = GET
- P = POST
- U = PUT
- D = DELETE

CoAP Message Types

CNAR

- C = Confirmable
- N = Non-confirmable
- A = Acknowledgement
- R = Reset

AMQP Components

PEQCB

- P = Producer
- E = Exchange
- Q = Queue

- C = Consumer
- B = Broker

🚀 TOPPER ANSWER WRITING TIPS

For protocol answers, always write:

```
Definition
↓
Need
↓
Working model
↓
Diagram
↓
Components
↓
Advantages
↓
Applications
↓
Conclusion
```

Must Draw Diagrams

✅ MQTT Publisher-Broker-Subscriber

✅ CoAP Request-Response Model

✅ AMQP Producer-Exchange-Queue-Consumer

✅ MQTT vs CoAP Comparison Table

Keywords to Underline

MQTT, Broker, Publisher, Subscriber, Topic, CoAP, Request-Response, Confirmable, AMQP, Exchange, Queue, XMPP, SMQTT

Final tip: Unit-4 me सबसे पहले **MQTT + CoAP + MQTT vs CoAP + AMQP** prepare करो. यही सबसे scoring topics हैं.