Atal Bihari Vajpayee Indian Institute of Information Technology & Management, Gwalior

IT406: IoT and Applications

Major Examination (Session 2023–24)

Maximum Time: 3 Hours **Max Marks: 70**

Note: Answer all questions. Diagrams, block-level designs and assumptions must be clearly indicated. Internal choice is provided where stated.

1. (a) Draw and explain a typical **three-tier IoT architecture** (device/edge/cloud). Describe the main responsibilities of each tier. (10 Marks)

   (b) For each tier, mention one technology or product (e.g., MQTT broker, edge runtime, cloud service) commonly used in industry. (4 Marks)

2. (a) Compare **MQTT** and **CoAP** in terms of design goals, transport, message model, and typical use-cases. (8 Marks)

   (b) When would you choose CoAP over MQTT? Give a concrete example. (3 Marks)

3. (a) Explain sensor interfacing considerations (sampling rate, ADC resolution, anti-aliasing, power consumption) when designing an IoT sensing node for vibration monitoring. (6 Marks)

   (b) Design a simple hardware block diagram for such a node (sensor, anti-alias filter, ADC, microcontroller, radio), and briefly justify component choices. (6 Marks)

4. (a) Discuss **energy harvesting** techniques applicable to IoT devices and the challenges in using harvested energy for continuous sensing. (6 Marks)

   (b) Suggest power management strategies to maximize device lifetime in a battery + solar harvester deployment. (4 Marks)

5. **Security Privacy** — Answer both parts:
   (a) Explain authentication and secure key provisioning for large fleets of IoT devices (consider manufacturing and post-deployment scenarios). (8 Marks)

   (b) Describe at least three privacy concerns specific to IoT data and propose mitigations. (4 Marks)

6. **Numerical / Capacity Planning** — A smart building has 2000 sensor nodes. Each node publishes a 50-byte message every 30 seconds. The MQTT broker is hosted in the cloud.
   (a) Estimate the total data (in MB) uploaded to the broker in one 24-hour period. Show calculations. (6 Marks)
   (b) If the broker enforces a QoS level causing retransmission of 10% of messages, recompute the data volume and comment on bandwidth implications. (4 Marks)

7. **Case Study (Real-world design) — 12 Marks**:
   A municipality wants to deploy an IoT-based smart parking system in a downtown area: parking sensors in 500 slots, gateways aggregating sensors (one gateway per 50 slots), and a cloud backend for reservation, billing, and analytics.
   Propose a system design covering:
   - Sensor gateway placement and communication technology selection (justify choices: LoRa, NB-IoT, Wi-Fi, BLE, etc.)
   - Data flow from sensor to user app (protocols, message formats, broker or REST API)
   - Security privacy considerations for users' location and billing data
   - A high-level cost/maintenance considerations and one scalability challenge with its mitigation.
   (12 Marks)

8. Write short notes on any **three** of the following (each 4 Marks):
   (a) Digital twin and its value in industrial IoT
   (b) Over-the-air firmware updates (OTA) — challenges and rollback strategies
   (c) Edge analytics vs cloud analytics
   (d) Time synchronization in distributed IoT systems (e.g., NTP vs PTP)
   (12 Marks)