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

IT406: IoT and Applications

Major Examination (Session 2024–25)

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

Note: Answer all questions. Diagrams and block-level designs will receive credit. State assumptions clearly.

1. (a) Draw and explain a **three-tier IoT architecture** (device / edge / cloud). Mention key responsibilities of each tier. (8 Marks)
   (b) For each tier list one industry product/technology (example: an edge runtime, cloud service, broker) you would choose for a scalable solution. (4 Marks)

2. (a) Compare **MQTT** and **CoAP** in terms of transport protocol, message model, reliability, and resource footprint. Give one scenario where CoAP is preferable. (8 Marks)
   (b) Explain DTLS in the context of CoAP and why it matters. (3 Marks)

3. **Sensor Node Design (12 Marks)**:
   A vibration-monitoring IoT node needs to sample at 2 kHz, perform local preprocessing (FFT-derived features), and send feature packets every minute.
   (a) Propose a hardware block diagram (sensor, anti-aliasing filter, ADC, MCU, memory, radio) and justify key choices. (6 Marks)
   (b) Discuss power management strategies to achieve multi-year battery life (sleep scheduling, duty cycling, energy harvesting options). (6 Marks)

4. **Networking Scaling (10 Marks)**:
   A deployment has 5,000 battery-powered sensors reporting once per minute to a regional gateway.
   (a) Suggest suitable wireless technology and justify (consider range, power, throughput). (4 Marks)
   (b) Describe gateway responsibilities (queueing, aggregation, security) and how to design for reliability (redundancy, failover). (6 Marks)

5. **Security Provisioning (10 Marks)**:
   (a) Describe a secure boot and key provisioning flow for manufacturing and post-deployment lifecycle of devices (include symmetric/asymmetric options). (6 Marks)

(b) List and explain three common attacks on IoT devices (example: firmware tampering, replay, device cloning) and corresponding mitigations. (4 Marks)

6. **Numerical / Capacity Planning (8 Marks)**:
   Each sensor sends a 60-byte payload every 30 seconds. Gateway aggregates and forwards messages to cloud with a negligible extra header. For 5,000 sensors:
   (a) Compute total data volume (in GB) per day. (b) If using QoS that causes average retransmission of 5%, recompute and comment on bandwidth/storage impact. Show calculations. (8 Marks)

7. **Case Study (15 Marks)**:
   A city plans a smart-streetlight project: 10,000 streetlights with sensors (light, motion), gateways, and a cloud backend for scheduling, monitoring, and predictive maintenance.
   Propose an end-to-end solution covering:
   - Network selection for device-to-gateway (justify choice), gateway-to-cloud connectivity, and backhaul redundancy.
   - Data pipeline (ingest, storage tiers, analytics for predictive maintenance).
   - Security and privacy considerations (device identity, secure update, user privacy).
   - A short rollout plan addressing scalability and maintainability concerns. (15 Marks)

8. Write short notes (answer any **three**, 4 marks each):
   (a) Over-the-air (OTA) update rollback strategy
   (b) Time synchronization in distributed IoT (NTP vs. PTP)
   (c) Digital twin and its role in IoT operations
   (d) Edge AI — pros and cons (12 Marks)