Exam paper

# Question 1

1. Identify three functions of gateway implement in fog computing architectures and briefly explain their operation. What are the limitations of a gateway based IoT architecture.

[13 marks]

1. Consider an agent device that wishes to send 250 bytes of information to a controller over a Bluetooth classic connection. A data frame contains 122 bits corresponding to the access code and header, and the maximum payload is 2,774 bits. If the frame is transmitted at 1Mb/s, no forward error correction (FEC) is applied to the payload, and a 16-bit CRC is appended to each packet, how much time will be required to complete the transfer?

[12 marks]

1. Describe briefly the different approaches to cloud virtualisation, explaining the advantages and disadvantages of each approach.

[10 marks]

1. Consider a 64-bit plaintext block 0xFFCCBF0DFEBB001C that is enciphered using a Feistel structure with a round function F(Ri,Ki) = (Ri << 4) XOR Ki, where << denotes the circular shift left operation. Ki is the sub-key used at round i. If the sub-keys at rounds 1 and 2 are K0 = 0x01010101 and K1 = 0xCB2ECF45, compute the cipher text at the end of these rounds.

[15 marks]

# Question 2

1. Explain the principle of Over-the-air (OTA) programming, discussing advantages and drawbacks of this technique. Explain how risks facing OTA programming can be circumvented and at what cost.

[10 marks]

1. Consider a LoRaWAN deployment operating over a channel with 250kHz bandwidth. The end devices are configured to transmit packets using the chirp spread spectrum modulation with spread factor SF = 7. An end device is configured to transmit payloads with maximum size of 190 bytes. These are preceded by a 14-byte frame header and 1-byte frame port. Additional 5-bytes accounting for the MAC header and message integrity check (MIC) are added to the payload and a forward error correction (FEC) with rate 4/5 is applied before transmission. The Gateway transmits a beacon every 120 seconds and a 1% duty cycle is imposed by regulation on end devices.
   * Assume the transmissions of an end device experiences no collisions or losses, and no packet fragmentation is allowed, how much time would be required to send 1,900 bytes of information to the gateway?

[10 marks]

* + If instead on average 10% of frame transmissions collide with those of other nodes or are corrupted by channel noise, how many bytes of information are delivered to the gateway in 20 minutes?

[10 marks]

1. Describe briefly the utility of MQTT retain functionality.

[8 marks]

1. A microcontroller operates with two phases and the following power consumption profiles:
   * Phase 1 (sleep): 0.001W
   * Phase 2 (compute): 0.25W

The microcontroller runs for 5% of the time in the compute phase and spends the rest of the time in the sleep phase. If the microcontroller is powered by a battery with a nominal voltage of 5V and a capacity of 22Ah, what is the total lifetime of the device?

[12 marks]