

Internet of Things



Los Del DGIIM, losdeldgiim.github.io

Doble Grado en Ingeniería Informática y Matemáticas
Universidad de Granada

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Descripción Klausur WS.

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Duración 90 minutes.

Ejercicio 1 (20 puntos).

- a) An 802.15.4 network is deployed in the following three application scenarios. Which CSMA/CA MAC Layer version would you use? Justify your answer.
 - I) (3 points) A smart home network, where only 10 temperature sensors are installed. Each sensor reports a measurement once per minute.
 - II) (3 points) A smart clinic network that transmits monitoring data about the patients and alarm notifications.
 - III) (3 points) A smart farm network, where the sensor nodes are distributed over a large area. Some coordinators are powered by solar battery.
- b) (4 points) When unslotted CSMA/CA is applied, at each trial the back-off window size will be doubled. However, it doesn't always lead to a longer delay, why?
- c) (3 points) Name one of the reasons why we need 6LoWPAN to support IPv6 over 802.15.4?
- d) (4 points) A single IPv6 packet with a size of 555 Byte (including the IPv6 header and its payload) is sent to an IoT device using 802.15.4 and 6LoWPAN. The IPv6 header is uncompressed and we use 6LoWPAN fragmentation. What would be the value of the datagram offset field in the 5th fragment? Justify your answer.

Observación. We assume each fragment has 72 bytes available for its payload.

Ejercicio 2 (15 puntos).

- a) Given the following three application scenarios, should we apply NB-IoT or 802.15.4 as the networking technique? Justify your answer.
- I) (3 points) We want to deploy a people counting sensor at the front door of each university building. The sensor data should be sent to the data sink periodically.
 - II) (3 points) We want to develop a sheep fence with motion sensors for a farm of about 900 square metres. We want to get an alarm/notification when a sheep tries to escape.
 - III) (3 points) A bicycle sharing company in Duisburg wants to develop a bicycle tracking system. Bicycles should be tracked at all times, including when they are left in an underground parking lot.
- b) (6 points) Provide the names of the two different types of channels used in NB-IoT, and explain what each of them are used for. On which type of channel do we send Paging messages?

Ejercicio 3 (20 puntos). In the lecture you learned about the application layer protocol MQTT.

- a) (4 points) Describe a scenario in which you would apply the retain flag of MQTT. Justify your answer.
- b) Given an MQTT configuration with four clients C1, C2, C3, C4 and a broker B:
- I) (3 points)
- C1 publishes a message to topic `basement/temperature`,
 - C2 publishes a message to topic `groundfloor/kitchen/temperature`,
 - C3 publishes a message to topic `secondfloor/bathroom/temperature`.
- C4 should subscribe to which topic to receive all messages from C1, C2 and C3?
- II) (3 points)
- C1 publishes a message to topic `bathroom/ceiling/temp`,
 - C2 publishes a message to topic `bathroom/floor/temp`,
 - C3 publishes a message to topic `bathroom/boiler/outlet/temp`.
- C4 should subscribe to which topic to get the environment temperature of the bathroom?
- Observación.* We do not want to receive any other types of measurements, e.g. humidity.
- III) (3 points) C1, C2, C3 subscribe to shared subscriptions `\$share/exam/iot/temp`. To which topic should C4 publish, such that C1, C2, or C3 will receive the message?
- c) (3 points) MQTT v5 introduced multiple new features, among them “Topic Alias”. While creating a “Topic Alias”, why should the central broker store the topic alias mapping?
- d) (4 points) Client C2 subscribes to the topic `a/b/c` with QoS level 0. Afterwards, client C1 publishes a message to the topic `a/b/c` with QoS level 2. Looking at the message headers: what is the QoS level between C1 and the broker? What is the QoS level between the broker and C2?

Ejercicio 4 (14 puntos).

- a) (6 points) A robot moves linearly with speed $v = 2 \text{ m/s}$. It starts at time $t = 0$ at location $m_0 = 0 \text{ m}$. We want it to send us its location with the “Distance-based Reporting” protocol from the lecture with an accuracy of $\text{acc} = 10 \text{ m}$ and max speed $v_{\text{máx}} = 4 \text{ m/s}$. Write down the next three positions after m_0 (m_1, m_2, m_3) that the robot will report.
- b) (4 points) When the robot from Task a) keeps moving in the same direction with the same speed for a longer time, “Distance-based Reporting” leads to energy inefficiencies. Can we apply “Dead Reckoning” to make it more efficient? Justify your answer.
- c) (4 points) Describe a scenario where “Dead Reckoning” leads to energy inefficiency. Justify your answer.

Ejercicio 5 (11 puntos).

- a) In the following two IoT application scenarios artificial intelligence shall be used to solve a task. Would you deploy the AI (or a specific part of it) locally on an embedded device or in the cloud? Justify your answer.
 - I) (3 points) A voice-controlled virtual assistant (such as Amazon Alexa) shall wake up from a low-energy state on recognizing the user saying a specific keyword.
 - II) (3 points) Imagine a video surveillance system for intruder detection that includes a smart camera. If a suspicious object is detected in the scene, it must be analysed whether it actually is an intruder.
- b) (2 points) Explain the difference between pruning and quantization of an artificial neural network.
- c) (3 points) How does magnitude-based pruning decide which weights to prune? Why can that decision lead to drastic performance drops?