Internet of Things (Spring 2025)

Exam Hand-in

These are the questions for the written part of the exam in Internet of Things, Spring 2025. Your grade will be based on your written answers to these questions and a follow-up oral exam.

The hand-in exam is composed of three questions. Each question contains several sub-questions. The first two questions concern a fictional system design. These questions each weigh 40% in the grading. The third question concerns concepts and topics introduced in class, and weighs 20% in the grading.

Q1 – Designing a networked sensor device for asset tracking (40%)

You are being asked to develop networked sensor devices that can track assets in a wildlife park, or rather, two different wildlife parks, and simultaneously measure motion state (acceleration) and particulate matter concentrations at the asset location.

Assets in this context can be
things e.g. cars/jeeps or
living beings, e.g. humans and a variety of animals

The locations:

Knuthenborg

lat/lon   54.811358, 11.5082552

Land area   1,600 acres

Mpala Research Center

https://mpala.org/

lat/lon   0.2882139,36.9017593

Land Area   48,000 acres

Laikipia Plateau, Kenya

Note that you have two different locations, and two types of assets (with lots of variations, e.g. types of vehicles, species of animals).
Please reflect on whether you can design or choose one device to fit all these cases, or whether you need to diversify. You are asked to narrow down, suggest examples and – importantly! - reflect on the differences between these cases, and on why you might have to exclude certain combinations.

The device should be capable of reporting location with an accuracy of at least 500 m (radius), but preferably better. It should also record state of motion (acceleration).

With regards to timing, the device should be capable of recording a data point every one (1) hour, and preferably report instantly. Please make meaningful decisions and explain those and their connection to networking and system choices.

Note: The use case and overall requirements given are far from complete or precise. You are free and expected to make reasonable assumptions based on the use case intended, and reflect on them and their impact on your system design. A discussion of these aspects on our shared Q&A on LearnIT is encouraged.

A) Formulate functional and non-functional requirements for such a system.

B) Describe the architecture and interfaces of all components of this system. In particular, you should consider:

   i.   Sensor types and examples of concrete sensors

   ii. Embedded board and its components

   iii. Physical casing of the device

   iv. Possible energy sources for the device

   v.   Network type(s)

   vi. Payload format – What is being measured and what is being sent? Including sending frequency.

   vii. Duty cycle – When should the device be active, and when should it sleep? And for how long?

C) Reflect on the trade-offs in your design. e.g. between energy, networking and payload format/frequency.

Q2 – A data platform for tracking and monitoring (40%)

Now consider a complete monitoring system based on the sensor devices you designed in Q1.

A) Describe the system architecture and motivate your design choices. Include a system diagram describing the full system and data flow from sensor device to analytics application.

B) Discuss the role of analytics, including machine learning and forecasting, in your design. You should include the type of data to be processed and the location of data analytics within your system.

   i. Which decisions or ratings do you assume to be of interest, based on your data analytics?

   ii. Could you imagine combining the sensor data with data from other sources to augment your analytics? Give examples of data sources and the analytics they could enhance.

C) Discuss the scalability of your system. E.g. How would your system adapt to an increase in the number of sensor nodes, end-users, or the geographical distribution of these? What are possible bottlenecks in your system design, and how could they be addressed?

Q3 – Topics from class (20%)

A) What is the difference between sensor precision and sensor accuracy?

B) What is MQTT? What role does it play in IoT?

C) Characterize on all relevant layers Wi-Fi, Bluetooth, LoRa and LoRaWan and their use in IoT.

D) Name and explain security features of the LoRaWAN protocol.