Internet of Things (IoT) and Cloud Computing

Mini-project

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Connectivity

Mini-project description

1. Each group will get an IoT device with sensors and cellular connectivity

   Send an email to jojako21@student.aau.dk and CC me to collect them.

2. Choose an IoT application from the catalogue

3. Throughout the course, you'll setup the kit, perform measurements, and change the configuration to complete one or more short exercises

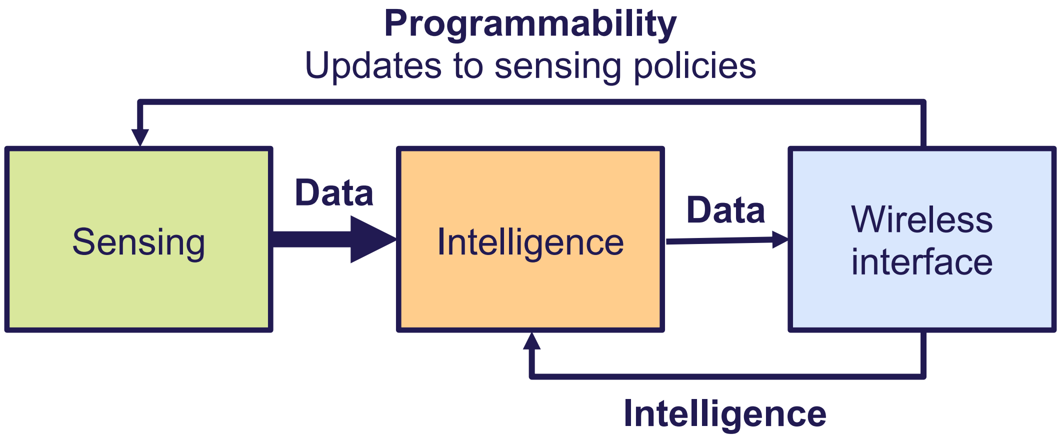
   These exercises will be useful to familiarize with the setup and that can be useful for solving the selected problem.

4. Present your solutions to the problems of the selected application

   Lecture 11 (April 27)

5. Write and hand-in a report with the solutions before the exam (date TBD)

Smart IoT setup



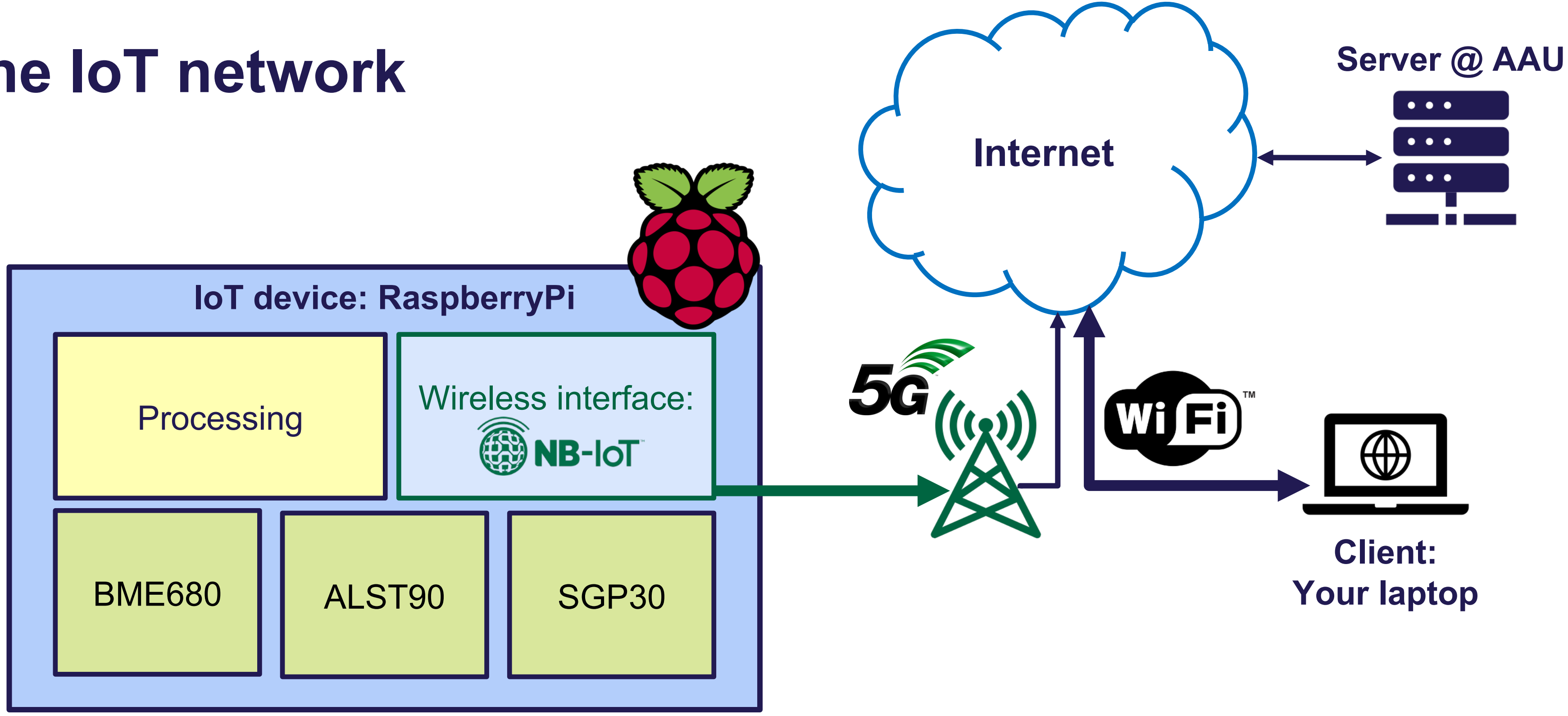
Setup

Your IoT device: Raspberry Pi 3 Model B+
Sensors: Your choice

Connectivity:

- WiFi
- NB-IoT
- Cable

The IoT network

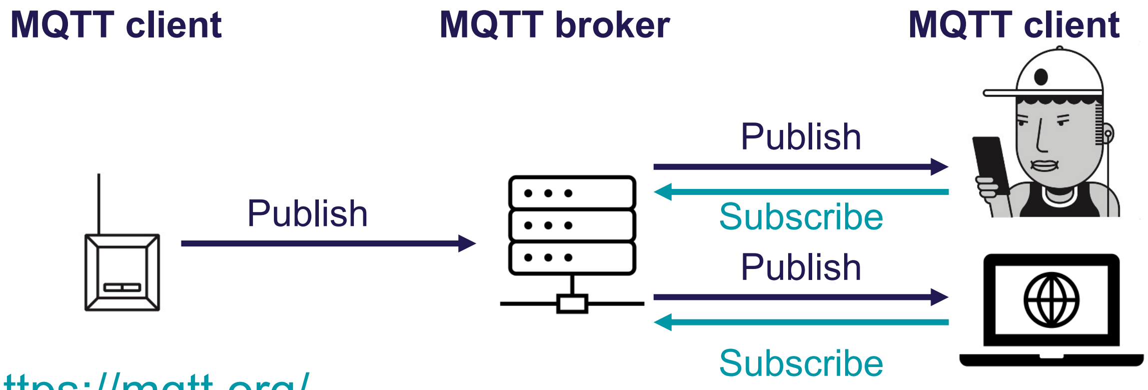


*Sensor models are only indicative

MQTT

Lightweight transport protocol for the IoT

Architecture



More info: https://mqtt.org/

Goal

Achieve accurate and energy-efficient data collection and transmission

- Implement a smart data collection strategy
- Implement an intelligent agent to decide which data to transmit and how

Make a report (10 pages max.) with the following.

- Explanation of the data collection and transmission policy
  - How frequently is data being collected?
  - What fraction of the collected data is transmitted?
  - Are you running calculations in the Raspberry Pi? Which ones?
  - Can there be errors and uncertainties in the reported data?
- Energy consumption and battery lifetime based on a theoretical model

Catalogue of IoT applications

Application 1: Smart lighting assistant

Use a light sensor to:

1. Obtain statistics of the room luminosity in 10-second intervals
2. Detect and timestamp periods when lights are turned on and off, using hysteresis to avoid false triggers from noise or transient changes
3. Alert the client when artificial lighting is on but natural luminosity is already sufficient, and report daily statistics on unnecessary lighting periods

Application 2: Cognitive impact monitor

Use a CO_2 and VOC sensor to:

1. Obtain and record statistics of CO_2 equivalent and VOC levels in 1-minute intervals, e.g., in a group room during a work session
2. Detect and timestamp periods when CO_2 exceeds cognitive impact thresholds (e.g., >1000 ppm linked to reduced concentration, >2000 ppm linked to significant impairment)
3. Estimate how many minutes remain before CO_2 reaches the next cognitive impact threshold, and alert the client in time to ventilate

Application 3: Room comfort and ventilation advisor

Use a temperature and CO_2 sensor (and optionally humidity) to:

1. Define a joint comfort zone combining temperature (e.g., 19–23°C) and CO_2 (e.g., <1000 ppm), and compute a comfort index in 1-minute intervals indicating whether both conditions are simultaneously satisfied
2. Alert the client to open windows when CO_2 is too high, and to close them when temperature drops below the comfort zone — reflecting the inherent trade-off between ventilation and thermal comfort
3. Infer and timestamp ventilation events from sudden changes in temperature and CO_2, and measure the recovery rate of both parameters after each event
4. Compare time spent inside vs. outside the joint comfort zone across different ventilation strategies

Application 4: Room occupancy characterization

Use all available sensors to:

1. Infer room occupancy from correlated signals across all sensors (CO_2 rise rate, temperature rise, light changes) and timestamp detected occupancy periods
2. Characterize occupancy sessions: detect arrival and departure events, and compute session duration and environmental load (peak CO_2, temperature rise) per session
3. Build daily and weekly occupancy patterns: how often is the room used, at what times, and for how long?
4. Compare sensor-inferred occupancy patterns against any available ground truth (e.g., known schedule) and discuss sources of error