Aston University

Assessment brief

Academic Year 2020-21

Module:	EE4IOT - Internet of Things
Assessment Title:	The design and analysis of an Internet of Things prototype product.
School:	EAS, EEPE
Module Co-ordinator:	Dr. Richard Nock
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Office hours:	View and arrange on WASS: https://wass.aston.ac.uk/pages/viewcalendar.page.php?makeapp=1&cal_id=2093
Hand in deadline dates:	Week 25
Hand back date:	Within 20 working days of the deadline.
Re-assessment hand in deadline date:	To be arranged during the referral period. Note that equipment will be available on loan.
Assessment Summary:	To design and implement an IoT prototype product and document the design via a technical report.

Learning outcomes to be assessed:

On successful completion of this module a student will have demonstrated knowledge of:
1. Advanced technologies and protocols for networked devices.

On successful completion of this module a student will have demonstrated the ability to:
2. Analyse complex problems and design systems that use networking technologies and microcontrollers to create a solution (design).

3. Create IoT system firmware (microcontroller code) capable of transmitting sensor data over a network.

4. Evaluate the societal, privacy and commercial impact of IoT systems.

Coursework task

Your task is to develop an IOT prototype device using the Aston IOT trainer boards. A local company is interested in monitoring employee temperatures for COVID-19 monitoring purposes and has hired you to develop a proof-of-concept design.

To gain access to the premises, an employee must present their RFID card to the device. Upon a successful scan of the RFID card's unique identifier, the device will measure the user's body temperature. Upon measurement of the temperature, the device will then record this access attempt and will grant access if their bodily temperature is within an acceptable range.

Each device must connect to the existing WiFi network which exists on-site.

The system must have the following features/functionality:

1. It should check to see if an RFID card has been presented every 100ms. Whilst doing this, the LCD should display a message on the **top line** to let users know to scan their cards.

2. Upon being presented with an RFID card, the device should measure the temperature of the user. For this, assume that the potentiometer output represents the analogue output of an infrared temperature sensor pointed at the user, with the following response:

Fully anti-clockwise: 25°C.

Fully clockwise: 45°C.

After taking a measurement of the temperature, display the value on the **top line of the LCD for 2 seconds**.

3. After measuring the temperature, transfer the values of:

   a. The RFID tag's unique identifier.

   b. Temperature.

   c. The devices' unique identifier (for localisation purposes). This is a string which can be used to identify where the device has been installed.

Over the local network using **a webpage** and over the internet using **MQTT with SSL/TLS**. The webpage should display the last 10 access attempt UIDs and their corresponding temperatures.

4. If the temperature is within a user programmable range, such as 36.5 to 38°C, illuminate the LED for one second to simulate the door solenoid being allowed to open. Otherwise, do not illuminate the LED, and inform the user that they must return home.

5. Be able to set the upper and lower bodily temperature limits via **MQTT** and a **HTTP** server.

6. Update the bottom line the LCD on start-up with the **IP address**.

7. Implement a device discovery algorithm, which responds to a UDP broadcast message with the board's IP address OR use some form of multicast DNS system such as **mDNS.**

8. Use a task scheduler where possible to handle the devices various processes after initialisation.

The coursework's deliverables consist of a technical report to be submitted through Blackboard and a code submission.

Technical report/assessed elements

Your report should include all diagrams in the main body of the report and not in an appendix. The font should be Arial size 12pt with single line spacing. All diagrams should have figure numbers and be referenced from within the text. Numeric (IEEE style) references should be used instead of Vancouver or Harvard style references.

1. Design and implementation (25%)

You should discuss your design (which meets the requirements determined by the specification given earlier). The design should be introduced with a block diagram and each major building block should have its own subsection discussing the design process and the rationale behind the design. Full code listings **must not** be given in this section (as a copy of the Arduino sketch forms a part of the assessment submission) although state diagrams, flow-charts, pseudo-code, and code snippets etc. are recommended to assist in the design description.

2. Societal / privacy / commercial impact analysis (25%)

An evaluation and numerical estimation (where appropriate) should be made on:

- How efficient is your way of powering the IoT product? How does your selected way of powering the IoT product impact the environment?
- The privacy and security of data transmitted. How is trust established? How can the situation be improved?
- Potential societal or ethical implications.
- If the product be taken forwards to commercialisation and if so, a comparison should be made to similar products on the market to estimate the products potential.

3. Deployment considerations (25%)

- Estimate the potential range from IoT product to WiFi access point given free space conditions and estimate the number of devices that maybe required in a typical scenario.
- Consider total deployment cost (cost per unit), running cost (based on power consumption).
- Consider ways to future proof the design via stringent verification or over the air programming.

Code submission

4. Code (25%)

As part of the assessment submission, you must include a copy of your Arduino sketch as a zip file. The code will be analysed to ensure it follows from the design and implementation discussed in 1. Functionality, efficiency and style/formatting will be taken into account.

Your code and project reports will be analysed using automated tools for plagiarism. If evidence of plagiarism is found, standard university penalties will be applied.

Deliverables:

Submission will be electronic through Blackboard. Your deliverables comprise of:

Deadline (week)	Details
25	1) A technical report submitted as a PDF document to Blackboard. 2) A zip file containing your Arduino sketch for the IoT hardware platform.

The design of this prototype will be driven by the weekly laboratory sessions. Hence, students must document and maintain a lab book (OneNote is recommended) such that they will have suitable background content for the report.

Resources:

- IoT hardware platform and necessary cables.
- Laboratory PC with Arduino development environment installed.
- A laboratory PC acting as a wireless access point or a mobile phone as a WiFi hotspot.

Workload:

This assessment should require approximately 20 hrs to complete in addition to the laboratory sessions, the ease of which being dependent upon participation in laboratory exercises.

Marking scheme

	<50% Fail	50-59%	60-69%	70-79%	80% + (publishable work)
1. Design and implementation (25%) Maps to learning outcome(s): 1,2	The design does not align to the specification given. The implementation has major errors or omissions inhibiting its function.	The design fulfils the specification and aligns well with the specification. The implementation functionally works. The design has potential for improvements. Security concerns are considered, but may not be fully sufficient or contain errors prohibiting the development of a robustly secure device.	The design fulfils the specification and aligns strongly with the specification, demonstrating a coherent design process. A strong critical rationale is given for design choices. The implementation functionally works and efficiently covers all aspects with room for minor improvements.	The design fulfils the specification and aligns strongly with the specification, demonstrating a coherent design process. A strong critical rationale is given for design choices. The implementation fully works and efficiently covers all aspects.	The design fulfils the specification and aligns strongly with the specification, demonstrating a coherent design process. A strong critical rationale is given for design choices. The implementation fully works and efficiently covers all aspects. The design and approach is novel and is worthy of publication.
2. Societal / privacy / commercial impact analysis (25%) Maps to learning outcome(s): 4	The various aspects are briefly mentioned. However, the environmental impact, entrepreneurial possibilities and ethical issues are not evaluated sufficiently.	The various analyses are performed to an adequate level and numerical estimates are based on typical scenarios. Security/privacy analysis maybe lacking or suggestions for improvements might be superficial.	The various analyses are performed to an adequate level and numerical estimates are based upon both typical scenarios and the product. Suggestions for security/privacy improvements are feasible for microcontroller implementation.	The various analyses are performed concisely and evaluate a broad range of issues with accurate numerical estimations. All suggestions are based upon good engineering practice and are suitable for microcontroller implementation.	The various analyses are performed concisely and evaluate a broad range of issues with accurate numerical estimations. The quality of the analysis is sufficient for publication. Techniques suggested for improved are truly novel.
3. Deployment considerations (25%)	Deployment considerations are not covered or are overly superficial.	Deployment considerations are accurate and likely to be of use in actually	Deployment considerations are accurate and likely to be of use in actually	Deployment considerations are accurate and likely to be of use in actually	Deployment considerations are accurate and likely to be of use in actually deploying an IoT product.

		deploying an IoT product.	deploying an IoT product. Estimates are based on numerical estimates from typical use case scenarios.	deploying an IoT product. Estimates are based on numerical estimates from typical use case scenarios and best and worst case figures are provided.	Estimates are based on numerical estimates from typical use case scenarios and best and worst case figures are provided. The analysis performed is to a professional quality.
4. Code (25%) Maps to learning outcome(s): 3	The code is incomplete, non-functional or is incomplete.	The code implements all functionality and works. However, there may be minor issues which could cause problems in rare circumstances.	The code functions and fully meets the specification. The formatting utilised follows recommended laboratory guidelines.	The code functions and fully meets the specification. Code is efficient with no apparent flaws. The formatting utilised follows the recommended laboratory guidelines.	The code functions and fully meets the specification. Code is efficient with no apparent flaws. The programming is of a professional quality (in terms of efficiency, layout and style). The formatting utilised follows the recommended laboratory guidelines.