Faculty of Arts, Computing, Engineering & Sciences
Department of Engineering and Maths
**BEng (Hons) Computer Systems Engineering**

Sheffield Hallam University

| **Module** | | |
|---|---|---|
| **Code** | **Title** | **Module Leader** |
| 55-600336 | Architectures for the Internet-of-Things | Alex Shenfield |

| **Assessment** | | | | |
|---|---|---|---|---|
| **Title** | | | **Weighting** | **Assessment ID** |
| Prototyping an Internet-of-Things enabled “smart” home | | | 50% | 1CWK50 |
| **Submit to:** | | | **Deadline** | |
| **Help-desk** | **Blackboard** | **Other** | 14/01/2019 | |
| | x | | | |
| ***Late submissions will incur a penalty according to University regulations*** | | | | |

**Additional submission details:**

This assignment also involves a compulsory demonstration of the completed system (worth 55%). This demonstration will occur in the lab session in week 25 or 26.

**In this assessment, the student will demonstrate the ability to:**

- Understand the benefits, challenges and pitfalls of developing internet enabled embedded systems.
- Evaluate state-of-the-art protocols and technologies for enabling communication amongst distributed embedded sensor nodes.

| **Assessment Elements** | **Weighting (%)** |
|---|---|
| | |
| Report | 30 |
| Circuit diagrams and source code | 15 |
| Demonstration and technical functionality | 55 |
| | |
| **Total** | **100%** |

**Prototyping an Internet-of-Things enabled "smart" home**

## Assignment Brief

"Smart" home automation such as Nest[1] and the British Gas Hive[2] system (see Figure 1) provide a user friendly way of controlling both heating and lighting systems in the connected home from anywhere in the world. As well as the smart thermostats shown in Figure 1, both Nest and Hive now offer a range of other smart home technologies (from light-bulbs to smart plugs to door sensors and cameras). This allows the end-user to have much greater control of their home appliances and has the potential to create savings on both electricity and gas bills[3] [4].


a) The HIVE "smart" thermostat | b) The NEST learning thermostat

Figure 1 – Commercially available "smart" thermostats

However, home automation systems are not just about convenience and money saving. The evidence that our climate is changing is undeniable and it's clear that if we fail to significantly reduce our carbon emissions the consequences will be disastrous. Carbon emissions from the residential sector are second only to that of the business sector in the UK[5]. Home automation systems capable of intelligent monitoring and control of heating and lighting systems will allow significant reduction in these residential carbon emissions to be made - potentially helping the UK to meet existing carbon emissions targets by reducing energy wastage via minimising unnecessary use of heating and lighting (for example, in areas that are unoccupied).

In this assignment you are required to design and build a prototype smart home system capable of being controlled remotely over the web.

1 https://store.nest.com/uk/
2 https://www.hivehome.com/
3 https://www.theguardian.com/environment/2015/jan/27/smart-thermostats-reviewed-which-can-save-you-most
4 http://www.thisismoney.co.uk/money/bills/article-3069277/How-spend-300-heating-bill-using-smartphone.html
5 ONS, 2011, http://www.decc.gov.uk/assets/decc/11/stats/climate-change/4817-2011-uk-greenhouse-gas-emissions-provisional-figur.pdf

## Core functionality

The core functionality required from smart home systems is:

- the acquisition of temperature and light data
- the transmission of that data over the web to a central server / broker
- the automatic control of the heating system based around temperature set points (it is acceptable to simulate this with an LED for the purpose of this prototype)
- triggering the lights when the light level drops below a certain point (again, using an LED is acceptable for this protoype).

## Desired functionality (guidance only)

There are several aspects of desired functionality for this system that would be of great benefit to both the usability and the utility of this system:

- ability to adjust the temperature and light set points of the system
- integral display of system data
- manual overrides (to enable turning the heating and lighting on or off manually)
- ability to vary temperature set point with time of day
- implementation of a security system (e.g. either using push buttons to simulate intruder detection or – preferably – using PIR sensors or similar) with both local and remote notifications
- other innovative features of your own design!

## Marking Scheme & Deliverables

The investigation should produce the following deliverables:

1. A report detailing the design of your IoT enabled "smart" home system. This report should include:

    - a brief technology review investigating potential IoT architectures / protocols
    - an architectural overview of your system including the justification of all key design choices you have made (including the hardware selection)
    - thorough evidence of testing
    - conclusions and further work (i.e. how to go from this prototype stage to production and any proposals for additional features with full justification).

    Your report should be clear, concise, well structured, and well presented. This report should ideally be no more than 10 pages (excluding appendices) and include an introduction section, details of the work carried out, and a conclusions section.

    [30%]

2. The source code and circuit diagrams for all components of your system.

    [15%]

3. A 10 minute demonstration of the completed prototype (assisted by appropriate presentation media – e.g. powerpoint) showing off the features of your system.

**40%** will be available for the technical features and functionality you demonstrate.
**15%** will be available for the presentation itself.

Presentations will be marked on:

- Clarity of verbal presentation and presentation structure
- Appropriate use of images
- Content coverage
- Ability to answer questions

**These demonstrations will be in week 25 or 26 and it is your responsibility to organise a time to do your demonstration on this date.**

[55%]

A detailed breakdown of the allocation of marks is provided in Appendix A.

**Appendix A**

Marking grid:

| | **1st (> 70%)** | | | **2:1 (60% - 69%)** | | | **2:2 (50% - 59%)** | | | **Third (40% - 49%)** | | | **Fail (< 40%)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Report (30%)** | An exceptional report has been produced describing the completed system in detail and justifying all the design decisions made. Ample evidence of both the construction of the system and testing is provided. The report covers in detail all areas listed in the marking scheme and deliverables. | | | A well written and clear report has been produced that demonstrates a good understanding of the development of IoT applications and the construction of the prototype system. The are minor shortcomings and areas for improvement in the report. | | | A good report has been produced that captures the IoT systems design in some detail – however, improvements to the report and greater detail of the construction / analysis / testing process were needed. | | | An adequate report has been produced that demonstrates an understanding of the key points of the development of an IoT application. Some detail about the construction / design of the prototype system is lacking and the analysis could be improved. | | | A poor quality report has been produced with little to no technical content or attempt to justify the design decisions made. | | |
| | H | M | L | H | M | L | H | M | L | H | M | L | H | M | L |
| **Code and circuit diagrams (15%)** | Full, well written source code has been provided for the embedded IoT system components as well as clear and well laid out circuit diagrams (using a design package such as Fritzing or Eagle). | | | Clear code and circuit diagrams that can be easily replicated have been provided. | | | Code and circuit diagrams have been provided that, whilst clear enough to replicate, are somewhat lacking in professional quality. | | | Code and circuit diagrams have been provided for the system and components but these are somewhat lacking in clarity. | | | Little to no attempt has been made to provide code or circuit diagrams for the system components or poor and unclear versions have been provided. | | |
| | H | M | L | H | M | L | H | M | L | H | M | L | H | M | L |

| **Demonstration (55%)** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Technical (40%)** | All basic functionality is implemented and working. An excellent range of appropriate additional features have been implemented and a professional prototype has been produced. | | | All basic functionality is implemented and working. A reasonable selection of additional features have been implemented, though some desirable features need work. | | | All basic functionality is implemented and working. Some implementation of appropriate additional features has been attempted – though more could be done. | | | All basic functionality is implemented and working. | | | Very few features have been implemented and little is working. | | |
| | H | M | L | H | M | L | H | M | L | H | M | L | H | M | L |
| **Presentation (15%)** | All the components and key features of the system are presented professionally and questions about design decisions are answered confidently. | | | A very good presentation addressing the main points of the system has been given – with some room for improvement. | | | A good presentation has been given addressing the main points of their system. | | | The presentation demonstrates some understanding of the system and some questions are answered. | | | The presentation demonstrates a lack of preparation, clarity and focus. | | |
| | H | M | L | H | M | L | H | M | L | H | M | L | H | M | L |