Feasibility Study

Thomas Scott

1st October 2018

1 Title

CoAP based IoT data transfer from a Raspberry Pi to Cloud

2 Learning Objectives

- Use knowledge, abilities and skills for further study and for a range of employment in areas related to scientific and technical computing.
- Interpret legislation appropriate to computer professionals and also be aware of relevant ethical issues and the role of professional bodies.
- Analyse, design, and implement algorithms using a range of appropriate languages and/or methodologies.
- Demonstrate an understanding of the characteristics and operation of various networking technologies and communication protocols.
- Conduct an investigation in usage and implementation of communication protocols.
- Identify and make use of current scholarly research in the field.
- Demonstrate effective communication, decision making and creative problem solving skills, and identify appropriate practices within a professional, legal and ethical framework.

3 Project Background

The Internet Engineering Task Force (IETF) standardised the Constrained Application Protocol 'CoAP' as RFC 7252 in 2014 —as a specialized web transfer protocol for constrained devices, constrained nodes and constrained networks in the Internet of Things 'IoTs'. (Bormann et al. 2015)

The Constrained Application Protocol (CoAP) is a software protocol that enables simple constrained "things" such as low-power sensors and actuators to communicate interactively via the internet. It runs on devices that support the User Datagram Protocol (UDP) and implements a lightweight application layer that suited for low-power, low-memory devices.

The goal of CoAP is to allow constrained devices to connect and communicate with one another over the Web. It accomplishes this by implementing a subset of the Representational State Transfer (REST) architecture and supporting Machine-to-Machine (M2M) features such as discovery, multicast support and asynchronous message exchanges.

The Internet of Things (IoT) can be viewed as a large distributed network comprising of highly dynamic devices (Miorandi et al. 2012). Small low powered "smart" devices can connect and communicate with one another. Some of these devices can contain or communicate with sensors that record real world data.

This data can then be transmitted to other devices allowing them to trigger actions. In this way groups of smart devices can be used to improve day to day situations such as automated houses (thermostats and heating etc.), security and improved monitoring.

The Raspberry Pi 3 Model B (Pi 3) is a credit card sized computer developed by the Raspberry Pi Foundation. This small device contains a 1.4GHz 64-bit processor, wireless LAN, Bluetooth, faster Ethernet, 40-pin GPIO header and 4 USB 2.0 ports. The Raspberry Pi (RPi)'s ability to act as a GNU/Linux server and the interfacing services provided by its general purpose I/O pins make it a popular choice of hardware for IoT applications. (Kumar & Rajasekaran 2016)

Cloud computing platforms enable the storage of data and the execution of programs on a remote widely accessible server. The use of cloud computing platforms allow users to access information from a variety of different locations and devices. With 48% of the UK market considering their smartphone as the most important device for internet access (Ofcom 2018) cloud platforms are a large part in providing services to users. Cloud platforms are often easier to scale, allowing the connection of more smart devices and therefore a larger connected network. This project will look at how CoAP can be used to transmit data to a cloud platform using a RPi as a smart device connected to a sensor.

4 Aims

The aim of this project is to investigate the implementation of CoAP technology and how to use CoAP to send data to the cloud.

5 Objectives

1. Explore existing research into using CoAP technology to send sensor data to a cloud service.
2. Identify ways in which sensor data can be transferred using CoAP.
3. Investigate and choose a cloud computing platform to send sensor data to.
4. Investigate the usage of CoAP over different transport layers. (UDP, TLS).
5. Compare CoAP to similar protocols (MQTT) that data to the cloud.
6. Implement a CoAP client on a Raspberry Pi which:
   (a) Connects to a sensor attached to the device
   (b) Connects to the internet
   (c) Can transmit data collected from the sensor to a cloud platform

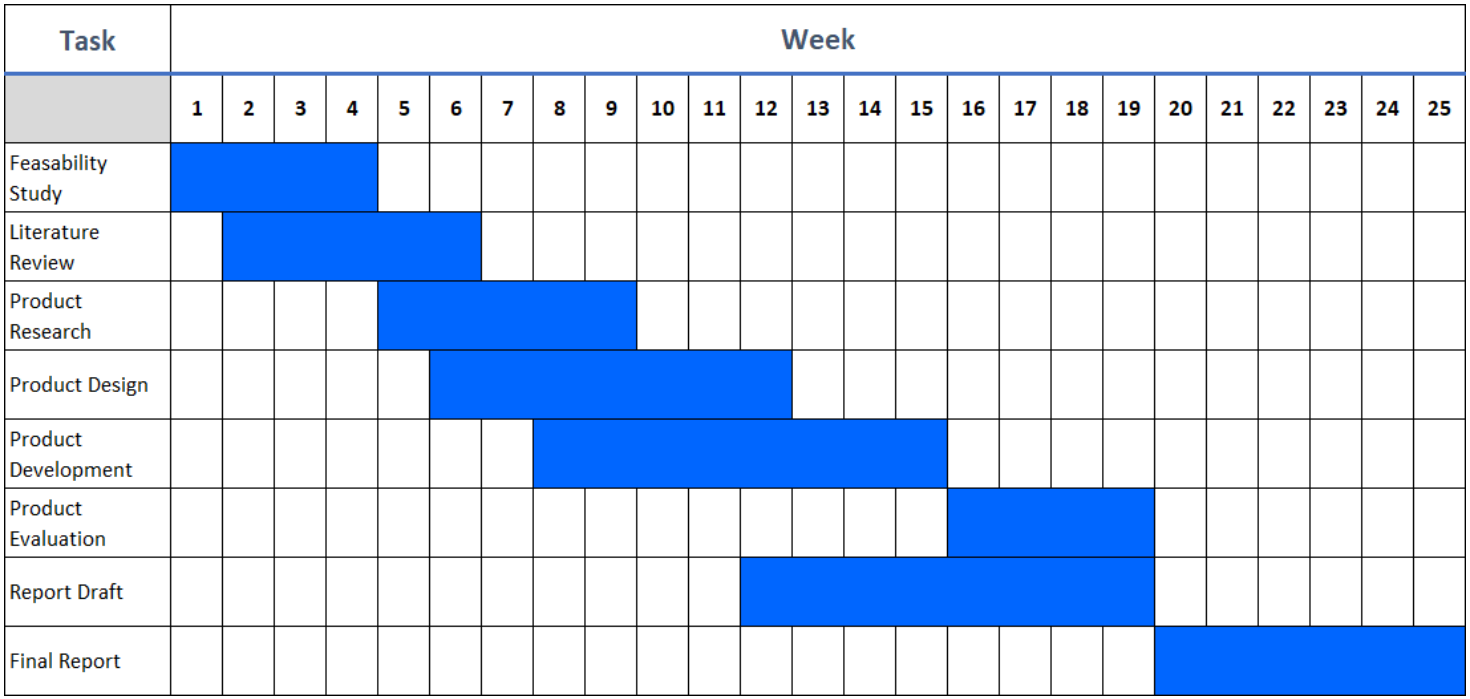
6 Required Resources

- Raspberry Pi 3
- Micro SD card
- Power cord
- Sensor
- Cloud Platform (To be selected as part of project)

7 Notable dates

Week	Starting	Requirement	Deadline
4	15/10/18	Feasibility Study submitted	19/10/18
12	10/12/18	Prototype Report uploaded	14/12/18
18	11/02/19	Product submitted	22/02/19
20	25/02/19	Report Outline uploaded	01/03/19
25	01/04/19	Showcase held	Specified day
25	01/04/19	Report submitted	05/04/19

8 Tasks and Timescale



Acronyms

CoAP The Constrained Application Protocol.

IoT Internet of Things.

M2M Machine-to-Machine.

REST Representational State Transfer.

RPi Raspberry Pi.

UDP User Datagram Protocol.

References

Bormann, C., Hartke, K. & Shelby, Z. (2015), 'The constrained application protocol (coap)', *RFC 7252* .

Kumar, R. & Rajasekaran, M. P. (2016), An iot based patient monitoring system using raspberry pi, *in* 'Computing Technologies and Intelligent Data Engineering (ICCTIDE), International Conference on', IEEE, pp. 1–4.

Miorandi, D., Sicari, S., De Pellegrini, F. & Chlamtac, I. (2012), 'Internet of things: Vision, applications and research challenges', *Ad hoc networks* **10**(7), 1497–1516.

Ofcom (2018), Communications market report, Technical report.
URL: *https://www.ofcom.org.uk/research-and-data/multi-sector-research/cmr/cmr-2018/report*

Pi, R. (3), 'model b', *Raspberrypi. org. Saatavissa: https://www.raspberrypi.org/products/raspberry-pi-3-model-b/* **6**, 2018.

Undergraduate and PGT Application

START HERE - Basic Information

This form must be completed for all student projects.

Before you proceed

Some activities inherently involve increased risks or approval by external regulatory bodies, so a proportional ethics review is not recommended and a full ethical review may be required.

These may include:

i. Approval from an external regulatory body (including, but not limited to: NHS (HRA), HMPPS etc.);
ii. Misleading participants;
iii. Research without the participants' consent;
iv. Clinical procedures with participants;
v. The ingestion or administration of any substance to participants by any means of delivery;
vi. The use of novel techniques, even where apparently non-invasive, whose safety may be open to question;
vii. The use of ionising radiation or exposure to radioactive materials;
viii. Engaging in, witnessing, or monitoring criminal activity;
ix. Engaging with, or accessing terrorism related materials;
x. A requirement for security clearance to access participants, data or materials;
xi. Physical or psychological risk to the participants or researcher;
xii. The project activity takes place in a country outside of the UK for which there is currently an active travel warning issued by the authorities (see info button);
xiii. Animals, animal tissue, new or existing human tissue, or biological toxins and agents.

If any of these activities are fundamental to your project, please contact your supervisor to determine if a full application is required.

This form must be completed for each research project which you undertake at the University. It must be approved by your supervisor (where relevant) PRIOR to the start of any data collection.

In completing this form, please consult the University's ACADEMIC ETHICAL FRAMEWORK for ethical research.

A1 Please confirm that you will abide by the University's Academic Ethical Framework in relation to this project.

- (•) Yes
- ( ) No

A2 Are you submitting this application as a learning experience, for a unit which already has ethical approval? (please confirm with your supervisor)

- (•) Yes
- ( ) No

A2.1 Approval reference (supplied by your supervisor)

A3 Student details

Title	First Name	Surname
	Thomas Lee	Scott

Email: thomas.l.scott@stu.mmu.ac.uk

A4 Supervisor

Title	First Name	Surname
Dr	Amna	Eleyan

Faculty: Science and Engineering

Telephone: 0161 247 1457

Email: A.Eleyan@mmu.ac.uk

A5 Which Faculty is responsible for the project?

Science and Engineering

A6 Course title

6G6Z1101 Project

A7 Project title

CoAP based IoT data transfer from a Raspberry Pi to Cloud

A8 What is the proposed start date of your project?

19/10/2018

A9 When do you expect to complete your project?

23/08/2019

A10 Please describe the overall aims of your project (3-4 sentences). Research questions should also be included here.

The aim of this project is to investigate the implementation of Constrained Application Protocol (CoAP) technology and how to use CoAP to send data to the cloud. How can CoAP be used to send data from a device to the cloud.

A11 Please describe the research activity

A sensor will be connected to a Raspberry Pi device. This device will then be used to collect sensor data. This data will then be sent from the Raspberry Pi to a cloud service using the Constrained Application Protocol (CoAP). Research will be conducted on how to implement the use of CoAP on a Raspberry Pi.
Investigation involves how the protocol sends the data and how the cloud can receive data using the protocol.
Further investigation into the use of CoAP will be done through literature review.

A12 Please provide details of the participants you intend to involve (please include information relating to the number involved and their demographics; the inclusion and exclusion criteria)

No participants, all data will be obtained from the sensor.

Project Activity

B1 Are there any Health and Safety risks to the researcher and/or participants?

- ○ Yes
- ◉ No

B2 Please select any of the following which apply to your project

- ☐ Aspects involving human participants (including, but not limited to interviews, questionnaires, images, artefacts and social media data)
- ☐ Aspects that the researcher or participants could find embarrassing or emotionally upsetting
- ☐ Aspects that include culturally sensitive issues (e.g. age, gender, ethnicity etc.)
- ☐ Aspects involving vulnerable groups (e.g. prisoners, pregnant women, children, elderly or disabled people, people experiencing mental health problems, victims of crime etc.), but does not require special approval from external bodies (NHS, security clearance, etc.)
- ☐ Project activity which will take place in a country outside of the UK
- ☑ None of the above

B2.4 Is this project being undertaken as part of a larger research study for which a Manchester Metropolitan application for ethical approval has already been granted or submitted?

- ○ Yes
- ◉ No

Data

F1 How and where will data and documentation be stored?

Data will be stored on the Raspberry Pi device and on the cloud platform.

F2 Will you be collecting personal data or sensitive personal data as part of this project?

- ○ Yes
- ◉ No

Additional Information

G1 Do you have any additional information or comments which have not been covered in this form?

- ○ Yes
- ◉ No

G2 Do you have any additional documentation which you want to upload?

- ◉ Yes
- ○ No

G2.1 Please attach a copy of any other materials relevant to this application

Type	Name	File Name	Date	Version	Size
Additional Documentation	RA_Project_SoftwareDevelopment_270918	RA_Project_SoftwareDevelopment_270918.pdf	18/10/2018 12:00:00 AM	1	369.0 KB

Signatures

H1 I confirm that all information in this application is accurate and true. I will not start this project until I have received Ethical Approval.

- ◉ I confirm
- ○ I do not confirm

H2 Please notify your supervisor that this application is complete and ready to be submitted by clicking "Request" below. Do not begin your project until you have received confirmation from your supervisor - it is your responsibility to ensure that they do this.

Signed: This form was signed by Amna Eleyan (A.Eleyan@mmu.ac.uk) on 19/10/2018 13:33

H3 By signing this application you are confirming that all details included in the form have been completed accurately and truthfully.

Signed: This form was signed by Thomas Lee Scott (thomas.l.scott@stu.mmu.ac.uk) on 19/10/2018 14:14

Research Insurance Checklist

Overview

Manchester Metropolitan University holds insurance policies to cover claims for negligence arising from the conduct of the institution's normal business. This includes research undertaken by undergraduate and postgraduate students as part of their academic qualification as well as research carried out by staff.

If you are an undergraduate student, postgraduate student or staff researcher at the institution, you must complete all relevant sections of the checklist on the following pages to identify whether your application requires referral to the university's Insurance Officer.

Completing and submitting the checklist will ensure that your research study has appropriate insurance cover in place **before** it begins. Please submit your completed Research Insurance Checklist along with your Ethics Checklist and/or Application for Ethical Approval to your Faculty Research Officer.

Referral to the Insurance Officer

If your research falls into any of the categories listed in Section 2 and/or Section 3 of the checklist, the Faculty Research Officer will send the following information to the Insurance Officer at insurance1@mmu.ac.uk:

- Insurance Checklist
- Ethics Checklist and/or Application for Ethical Approval Form
- Participant Information Sheet(s) (if applicable)
- Participant Consent Form(s) (if applicable)
- Risk Assessment

The Insurance Officer will liaise with the insurers to gain approval. Please note some types of research may require additional insurance, which may incur an additional cost to the Faculty.

Research studies must not commence until insurance and all other relevant authorisations and/or approvals are given.

Travel Insurance

Manchester Metropolitan University has a policy to provide worldwide travel insurance for members of staff and students travelling in connection with their course or on an approved University trip. This includes travel undertaken in connection with undertaking a research study. You must complete the online travel insurance form to register for travel insurance and should do this at least two weeks before your departure date.

Please visit the Financial and Legal webpage for details.

High Risk Countries

Please visit the AIG Travel Guard website to identify whether the overall rating for the country you are travelling to is 'High Risk' or more severe. Please contact your Faculty Research Officer for guidance on accessing the relevant information on the website.

Research Insurance Checklist

ADMINISTRATIVE DETAILS

Lead Investigator Name (Title/Forename/Surname)	**Mr Thomas Lee Scott**
Contact Email Address	**THOMAS.L.SCOTT@stu.mmu.ac.uk**
Full Title of the Research	**CoAP based IoT data transfer from a Raspberry Pi to Cloud**

SECTION 1 – TECHNIQUES, TESTING AND INTERVENTIONS

Does your research study involve:

☐ **Physically invasive techniques?**

This refers to any test in which the skin of the participant is broken or an implement is inserted into any opening of the human body (e.g. eyes, ears, nose, mouth, lungs, stomach, rectum, vagina and urethra) or involves the taking of body samples such as saliva, hair, urine, faeces, sputum, skin, nails, or taking biopsies of any form for any purpose, or any form of scanning such as DEXA scans, Ultrasound scans, MRI, fMRI, CT, or PET scanning.

☐ **Ingestion of food stuffs or drugs?**

This refers to the consumption of any substance which may impact on psychological or physical state. Substances may include but are not limited to food, beverages or drugs.

☐ **Physical testing?**

This refers to any test in which a participant must perform an action resulting in the use of any muscle of the body and/or involves the use of scanning procedures, eye-trackers, mounted body cameras, sensors or electrodes, or the taking of swabs from any cavity of the body, respiratory challenge testing or recording of peak flows, EEG, ECG, Exercise ECG, Treadmill work.

☐ **Psychological intervention?**

This refers to any test which purposely alters the mood of the participant or involves administering personality inventories, or any other form of psychological test.

OR

✓ **I confirm that my research does not fall into any of the above categories *(please go straight to Section 3)***

SECTION 2 – CLINICAL TRIALS INSURANCE

Please complete this section only if you ticked one of the boxes in Section 1.

Does your research study involve:

☐ **Pregnant persons as participants with procedures other than blood samples being taken from them?**

☐ **Children aged five or under with procedures other than blood samples being taken from them?**

☐ **Activities being undertaken by the lead investigator or any other member of the study team in a country outside of the UK?** ***If 'Yes', please refer to the 'Travel Insurance' guidance on Page 1 of this form.***

OR

☐ **I confirm that my research does not fall into any of the above categories**

SECTION 3 – OTHER HAZARDS

Does your research study involve:

☐ **Working with Hepatitis, Human T-Cell Lymphotropic Virus Type iii (HTLV iii), or Lymphadenopathy Associated Virus (LAV) or the mutants, derivatives or variations thereof or Acquired Immune Deficiency Syndrome (AIDS) or any syndrome or condition of a similar kind?**

☐ **Working with Transmissible Spongiform Encephalopathy (TSE), Creutzfeldt-Jakob Disease (CJD), variant Creutzfeldt-Jakob Disease (vCJD) or new variant Creutzfeldt-Jakob Disease (nvCJD)?**

☐ **Working in hazardous areas or high risk countries?** ***Please refer to the 'High Risk Countries' guidance on Page 1 of this form.***

☐ **Working with hazardous substances outside of a controlled environment?**

☐ **Working with persons with a history of violence, substance abuse or a criminal record?**

OR

✓ **I confirm that my research does not fall into any of the above categories**