

Proposal_Theo_Rose

by Theo Rose

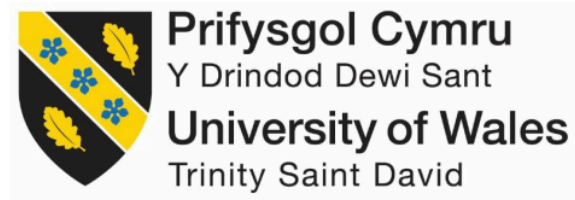
Submission date: 28-Oct-2024 02:24PM (UTC+0000)

Submission ID: 241186894

File name: 32802_Theo_Rose_Proposal_Theo_Rose_596981_2099005259.docx (134.82K)

Word count: 1957

Character count: 10522



The Design and Development of a Low Power LoRa Based Asset Tracking System

by

Theo Benjamin David Rose

Potential Supervisor: Stephen Mosey

Project submitted as part of the requirements for the
award of

BSc (Hons) Computing (stream)

*BEng (Hons) Embedded Electronics Systems Degree
Apprenticeship*

October 2024

Contents

Introduction:	3
Aims:	3
Objectives:	3
Deliverables:	4
Background to the Project/Literature Review:	5
Project Design:	6
Research and Development Methods:	6
Research:	6
Development Method:	6
Resources and Planning:	8
Resources:	8
Hardware:	8
Software:	8
Planning:	9
References	10

Introduction:

This project will focus on designing and prototyping a cheap, long range, low power asset tracking/management system which can be deployed anywhere without relying on the use of existing infrastructure such as Wi-Fi and cellular connection. This is required as most modern asset tracking systems deployed across large areas rely on existing infrastructure to achieve this which isn't practical in remote areas and can be very costly. [1]

Aims:

This project will focus on the design of a LoRa based low power communications system and how it can be utilised for asset tracking and management. LoRa is ideal for systems that require low power consumption, long range and can be deployed anywhere locally without relying on existing infrastructures such as Wi-Fi, cloud services or cellular connection which can be expensive and complex to setup. The idea behind this project is to utilise the LoRa based radio protocol to achieve low power and long-range communication between tracking tags and a central management system. This will be beneficial for remote areas where Wi-Fi and cellular is not easily accessible or where the system wants to be deployed locally without using cloud services but still maintain the same level of connectivity.

Objectives:

- Research current asset tracking solutions and find what the limitations are.
- Design a software simulation in Proteus of how each tracking module will operate and produce a circuit schematic of the internal configuration.
- Produce a prototype tracking module that is capable of sending LoRa packets to the central node with a python based graphical user interface for the user to interact with.
- Thoroughly test the prototype model to identify any problems that can be fixed before final PCB design and manufacture. Use anonymous surveys to capture feedback on how the prototype can be improved.
- Implement any suggested changes to the design and repeat the survey process
- After reaching a decision for the final working prototype, the final design can be manufactured. This will include a manufactured PCB and design, suitable case for the nodes to be deployed in, easy to use GUI deployed on the central node and a working demo for the users to see.
- Produce a final report summarising the design process and illustrate the results.

In order for this project to be a successful management of time is key. Any big changes to the design need to be established in early designing phases and therefore the initial design and user feedback are a priority. Careful consideration for cost and lead times of components need to be considered as some these components can take weeks to arrive.

Deliverables:

The deliverables for this project are:

- Interim Viva
 - Presentation
 - First Prototype of the System
- Final Report
 - Simulations
 - Circuit Design/Schematic
 - Flowchart of processes
 - Python GUI code
 - C code to operate the tracking nodes
 - PCB
 - Demo of the final working system
- Final Viva
 - Presentation
- Academic Poster

Background to the Project/Literature Review:

Current asset tracking systems rely on existing infrastructure to be in place such as Wi-Fi and Cellular access which can be expensive and complex to setup. [2] For Wi-Fi based systems, they also require multiple access points. Wi-Fi uses high frequencies to obtain high data rates and as a result will struggle to achieve reliable data transmissions at long range and penetration through walls. This is where LoRa is beneficial for this use case as it is capable of long transmissions distances with the drawback of lower data rates [3]. This trade off is acceptable as the tracking tags will need to benefit from the longer ranges but won't need to transmit large amounts of data. Another notable feature seen in existing asset management systems is the ability to take advantage of cloud processing for easy access and management of the system from anywhere. This feature is very useful and will be considered as an option in the final design. Looking at the additional features that these products offer it is important that this system design makes the most out of the existing technologies already developed.

The work achieved on this project will help mitigate the issues observed in the literature review. The key limitations of current asset management systems are that they rely on existing infrastructure for long range communication and they are costly. This project aims to reduce the complexity, cost and power consumption of the system and provide a product that is capable of being deployed anywhere. It will also make use of an unlicensed frequency bands that will not interfere with regularly used Wi-Fi and cellular interfaces. This follows the same connectivity requirements of existing system but utilises a different type of radio to obtain the low power consumption and longer range.

Existing products need to consider battery life and the power consumption of their devices. Small lithium batteries are generally used in asset tracking modules and can be harmful to the environment. Therefore, an alternative source of power such as energy harvesting can be investigated to see if it is a viable option for the low power system tracking nodes.

WiFi	Cellular	LoRa
Used frequently to assist in tracking assets in warehouses	Utilises masts across the country to send location data to management servers	Utilises low power radio module to transmit location data. Does not require internet connection
Advantages - widely used with large bandwidths and high data rates	Advantages - makes use of existing cellular infrastructure to track assets.	Advantages - Low Power consumption, cheap, long range
Disadvantages - Poor range and penetration. Will require multiple access point to cover a large warehouse. Costly	Disadvantages - uses the same bandwidth that for mobile data. They are dependant on mobile providers to keep the network running	Disadvantages - Low data rates due to frequency being used.

Table 1 – Comparison between different transmission systems for asset tracking

Project Design:

Research and Development Methods:

Research:

This project will have two main elements of research:

- The first element will cover a market survey to assess and analyse existing asset tracking solutions to determine a baseline design and any limitations that can be improved on.
- The second element will use survey/questionnaires directed at the users to identify key issues and improvements that can be made to the design. This will follow the rapid prototyping process outlined below.

Development Method:

This project will utilise a rapid prototyping development approach to design and build the system. Which will use anonymous surveys at each milestone of the design to capture feedback for suggested improvements. The design will be revised after each survey using the feedback to implement changes.

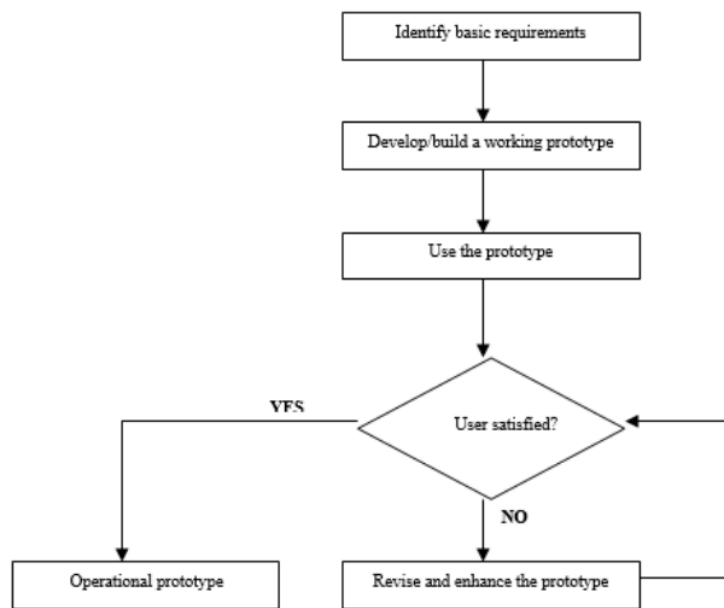


Figure 1 – Prototyping Process [4]

The flowchart seen in figure [1] outlines the process that the project will follow to successfully design and build the prototype asset management system. The type of prototyping used for this project will be “Evolutionary” as it will be “a prototype is built, then refined by improvements, adding further requirements until it meets a level of acceptability decided by the user - the prototype evolves into the actual, final system.” [4].

The main advantages of this approach are that any proposed design is assessed at multiple stages with constant feedback from the user to allow rapid adjustments and improvements as the project progresses [5].

The main disadvantages to rapid prototyping are the uncertainty of what systems will be used and how it will be designed. When making multiple revisions of the design; components can change which will likely result in an increase in cost and time as the product matures to the user's requirements [4].

As mentioned before, the key part of prototyping is to capture the user's feedback through the use of surveys and questionnaires to rapidly implement the improvements throughout the products lifecycle. The surveys and questionnaires used must be able to identify key improvements and problems of the system and can be rapidly improved upon as the product matures.

There are a few risks to this research method which will need to be considered:

- Firstly, the process of prototyping can be very time consuming and it is important to be aware of the time constraints of the project and to remain within those boundaries. As this project will follow a rapid prototyping method it is important to make the user known that this will not be a perfect system but will aim to meet the initial requirements set out in the problem statement. [4]
- Prototyping is a method of research that has a level of uncertainty and is vital that any major changes to the design are identified as early as possible to avoid unexpected delays. This is where early feedback from the user is very beneficial as it prompts the need for changes early in the design stage. [4]
- Cost and lead time of components is an important factor to consider as the system will change and develop throughout the prototyping process. To ensure no complications with lead times and costs the main components used will need to be decided early and shouldn't be changed later in the design process.

The data collected from these surveys will be anonymous and used to obtain the initial improvements after the first prototyping stage and will repeat that process to influence what technologies are used and how to best implement them depending on the feedback from the user. The initial design and choice of technology will be influenced by market research of existing products to establish a baseline of what the system must be able to accomplish. As each milestone of the design is accomplished the project will follow the process outlined in figure [1] to implement any changes needed before moving onto the next stage. This means that there will be many revisions of the hardware and software designed before manufacture to ensure that key problems are identified and fixed for the next iteration of the prototype.

Resources and Planning:

Resources:

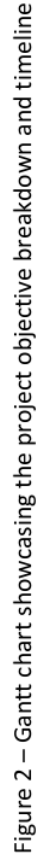
Hardware:

- Raspberry Pi capable of running a python GUI for asset tracking updates
- Microcontrollers - used to control the tracking modules
- GPS Module – to obtain
- LoRa Radio Modules
- Antenna

Software:

- Proteus
- Easy-PC/Kicad
- Python
- C (CCS)
- Linux/Windows OS
- Office 365

Independent Project



References

- [1] TracLogik, "WiFi Asset Tracking Technology and Solutions," TracLogik, [Online]. Available: <https://www.traclogik.co.uk/Asset-Tracking-Technologies/WiFi-Asset-Tracking>. [Accessed 16 10 2024].
- [2] UNABIZ, "SIGFOX 0G TECHNOLOGY BY UNABIZ," sigfox.
- [3] SEMTECH, "LoRa," SEMTECH, [Online]. Available: <https://www.semtech.com/lora>. [Accessed 12 10 2024].
- [4] K. Jones, "Information Systems Strategy Prototyping," UWTSD, Swansea.
- [5] J. Karen, "Rapid Application Development," Swansea, 2002.
- [6] B. D. T. G. C. H. M. G. D. J. R. C. K. O. K. W. Bradley Camburn, "A Systematic Method for Design Prototyping," *Journal of Mechanical Design*, 2015.
- [7] S. A. K. J. K. K. S. h. M. K. P. Kanakaraja, "Communication through black spot area using LoRa technology and IOT," *Materials Today: Proceeding*, vol. 47, pp. 3882-3887, 2021.
- [8] OFCOM, "UK Frequency Allocation Table (UKFAT)," OFCOM, 2022.
- [9] Link Labs, "RTLS GPS & Cellular Asset Tracking," Link Labs.
- [10] Ubisense, "A Comprehensive Guide to Asset Tracking Technologies," Ubisense, [Online]. Available: <https://ubisense.com/guide-asset-tracking-technologies/>. [Accessed 16 10 2024].
- [11] P. -H. L. a. K. Hung, "Development of an Asset Tracking and Monitoring Scheme for a Household Item-Sharing Service," in *IEEE*, Malaysia, 2019.
- [12] Z. A. D. V. A. O. D. a. M. C. N. Akram, "Design and Implementation of Asset Tracking System based on Internet of Things," in *7th International Conference on Electrical, Electronics and Information Engineering (ICEEIE)*, Malang, 2021.
- [13] V. D. a. J. E. R. Kaur, "Design, development and evaluation of an asset tracking system," in *Proceedings of the IEEE 31st Annual Northeast Bioengineering Conference*, Hoboken, 2005.
- [14] X. W. a. R. K. W. Zheng, "Personal asset tracking," in *2013 IEEE Long Island Systems, Applications and Technology Conference (LISAT)*, Farmingdale, 2013.
- [15] Teletrace Navman, "GPS Asset Tracking," Teletrace Navman, [Online]. Available: <https://www.teletracnavman.co.uk/equipment-management-software/asset-tracking>. [Accessed 15 10 2024].
- [16] K. Jones, "Academic Seminar Data Collection methods/tools," Swansea.

FINAL GRADE

GENERAL COMMENTS

78/100

Intro / A&O (400 words)		
Project title; Identification of a specific problem to be investigated; Well-defined aims and SMART objectives; Explaining why this project is worth doing; Discussion of what the project needs to do in order to be a success; Description any deliverables that will be produced at the end of the project	20	16
Clear project title relating to a specific problem. Well defined aim and SMART objectives.		
Background to the Project / Literature Review (400 words)		
Description of how the work to be done by in the project relates to the work identified in the literature review; Discussion of any ethical issues raised by the project Identifying what has already been done within the field; Topic familiarity; Brief literature review using appropriate sources – 6-8 journal papers and book chapters rather than just websites; Selection of relevant models & concepts	20	15

Excellent background to the project and a rationale for the completion of the project. Very good literature review with clear links to the project.		
Project Design (500 words)		
Clear statement of which development methods are to be used and why they are appropriate; Clear statement of which tools are to be used and why they are appropriate; Clear description of how data collected will be analysed	30	22.5
Very good clear statement of project methodology to be used along with a clear rationale. Clear statements of how data will be collected and processed.		
Resources / Planning (200 words)		
List of any deliverables; Clear diagram showing both timing and resource use; Completed ethics form; Limited and relevant appendices	15	12
Clear list of deliverables		
Good list of resources required.		

Excellent Gantt chart with complete list of tasks and durations.		
Completed ethics form		
Document Presentation		
Correct spelling, grammar and punctuation; Flow of narrative/fluency; Coherence; Word processed ; Correct use of referencing with bibliography; Strict word limit		
Excellent selection of relevant references, although some are missing some information e.g. [2], [4], [5] etc.	15	12
Very well written proposal. Well structured with a clear narrative.		
TOTAL	100	77.5

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10
