IMPLEMENTATION OF PROXIMITY BASED SERVICES
IN THE
CENTRAL LIBRARY, NIT CALICUT

Project report submitted by

MD. AZHARULLAH SHARIFF

B130727CS

in partial fulfilment for the award of the degree of

Bachelor of Technology

in

Computer Science and Engineering

under the guidance of

Dr. VINOD PATHARI

तमसो मा ज्योतिर्गमय

**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING,
NATIONAL INSTITUTE OF TECHNOLOGY, CALICUT
NIT CAMPUS P.O, CALICUT
KERALA, INDIA - 673601**

May, 2017

DECLARATION

I, hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person or material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning where due acknowledgement has been made in the text.

Place: NIT Calicut

Date: May 2, 2017

Name: Md. Azharullah Shariff

Reg. No: B130727CS

CERTIFICATE

This is to certify that this project report entitled "Implementation of proximity based services in the Central Library, NIT Calicut" submitted by **Mr. Md. Azharullah Shariff** (Reg. No. **B130727CS**) to the Department of Computer Science and Engineering, National Institute of Technology, Calicut towards partial fulfillment of the requirement for the award of the Degree of Bachelor of Computer Science, is a bonafide record of the work carried out by them under my supervision and guidance.

Dr. VINOD PATHARI

CSED, NIT Calicut.

Place: NIT Calicut

Date: May 2, 2017.

ABSTRACT

Beacons: Beacons are bluetooth low energy proximity sensing devices that can notify nearby bluetooth devices of their presence by transmitting information. They are discreet physical objects to put in physical locations, allowing smartphones to interact with them. When paired up with a custom-made application, this signal can be detected and can be used to trigger events on a mobile device such as a pop-up notification of information relevant to that specific location. They work with devices that are in the range of a few centimeters to fifty meters from the device in a real-world scenario.

The aim of this project is to develop a mobile application that the NITC community could use to make the process of borrowing a book from the library simpler and troublesome free, with the aid of beacon technology. With the application installed on their devices, the users can simply search for a book in the application itself and the selected book's location would be shown to the user on a custom map of the stack room in the library. The application also has a few other useful features with the help of which the user could keep track of books he has borrowed and would be notified about the latest arrivals in the library.

CONTENTS

1. INTRODUCTION

Beacons:

Beacons are small wireless devices that broadcast signals using Bluetooth Low Energy (BLE) or Bluetooth SMART technology. This technology is relatively new, first introduced by Apple in 2013. Since then, this technology has been put into tremendous use in various fields.

The signals broadcasted by these devices can be detected by 'beacon enabled' mobile applications and then trigger an action via the application in the form of a notification, sending a form, URL or other relevant media. Another potential use of this technology is to track users and their location / movements and collect the data for the purpose of generating real world analytics and insights.

How beacons work:

A beacon device is basically a small ARM computer integrated with a bluetooth smart connectivity module that runs on a lithium-ion battery. A beacon does not store any data, nor does it connect to the internet. It continuously emits 2.4 GHz radio waves where each signal comprises of packets carrying small amounts of data. Each bluetooth signal's body has only a few fields that carry information about the beacon's ID and the signal power.
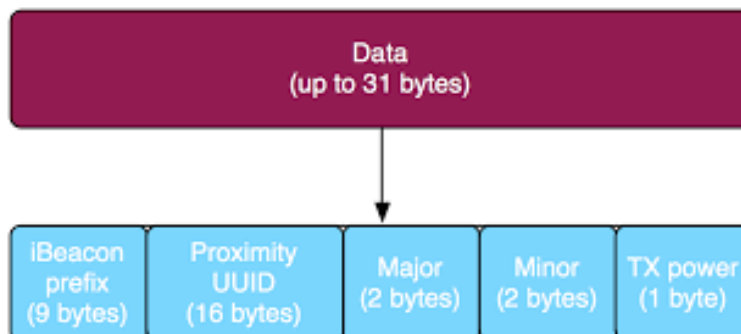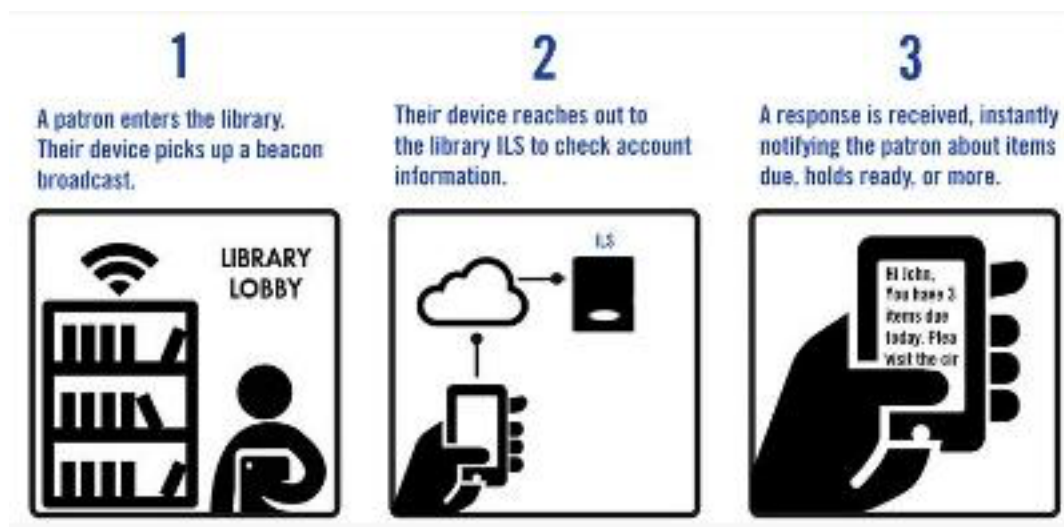
Beacons are platform independent where only the layout of the packet changes based on the manufacturer. Apple and Google have come up with their own beacon packet standards namely "iBeacon" and "Eddystone". For the project, the beacons were shipped from "Estimote", a manufacturer based in The United States and Google's Eddystone packet format is being used.

Application of beacons in the project:

In this project, the aim is to setup the beacon devices in the Central Library and help the users find a book's / rack's precise location in the stack room with the aid of a supporting mobile application. It would also be used to notify users about the various updates in the library (new books, journals, etc.) and also help them keep track of the books they have borrowed.

With the help of the mobile application, the users intending to borrow a book from the library would be able to search for a book on their mobile devices and would be guided to the book's location in the stack room, instead of having to search for a book in the OPAC search systems and manually search for the corresponding rack in the library.

The sequence of events for finding a book would be as simple as shown below:

1
A patron enters the library. Their device picks up a beacon broadcast.

2
Their device reaches out to the library ILS to check account information.

3
A response is received, instantly notifying the patron about items due, holds ready, or more.

1.1 Problem Statement:

To implement proximity based services powered by the beacon technology in the Central Library, NITC, to help the users find their required materials with ease and to keep them updated with the updates in the library.

1.2 Survey and Related works:

Although beacons is a relatively new technology, it is being used disruptively in various industries like in the airports, hotels, travel, construction, education, libraries etc.

Beacons are being extensively used in a few libraries in the US and UK for various purposes like locating items requested by the user, books checkout, contactless fine payment, etc. Some of them are the 'Boston Athenaeum', Boston, Massachusetts and the 'Orlando's Orange County' library system, Orlando. Within these libraries, beacons are being used to connect patrons with relevant electronic resources as they browse in specific sections of the library's stacks or share instructions in the library as patrons approach devices. This project is also along similar lines, helping users to find their required materials easily and keeping them updated with the latest publications and arrivals.
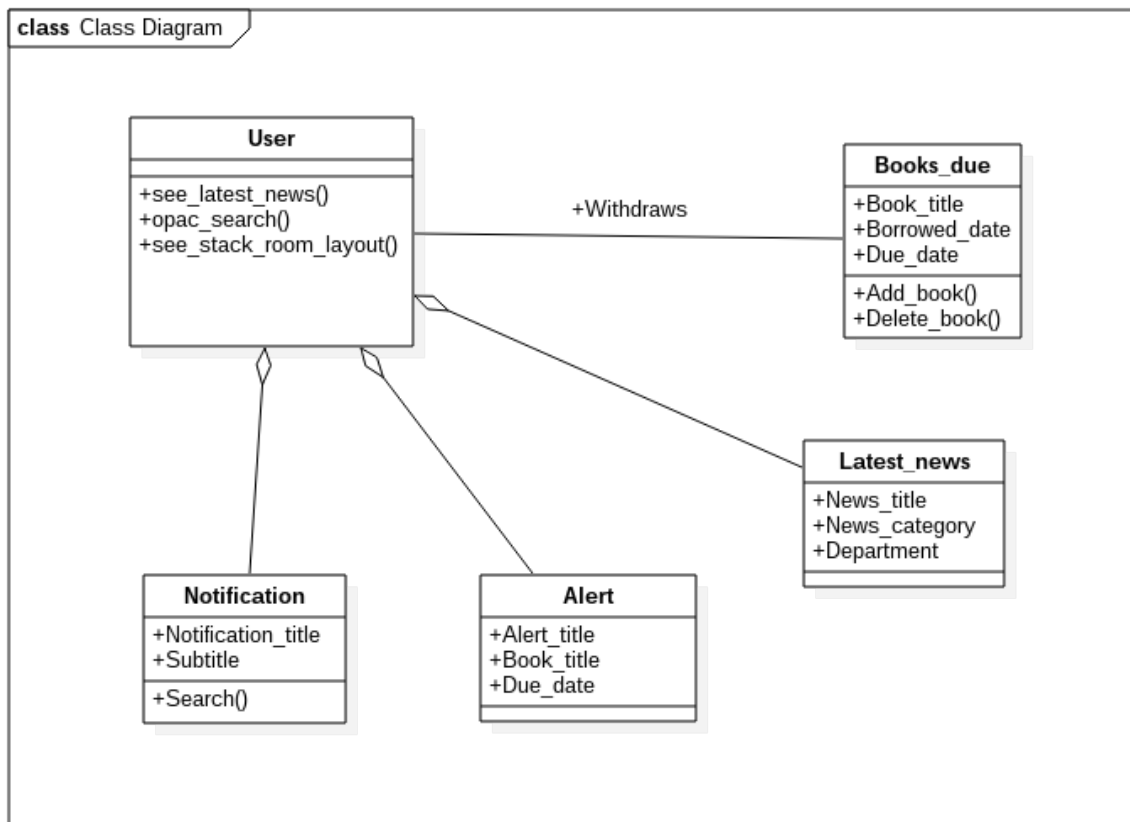
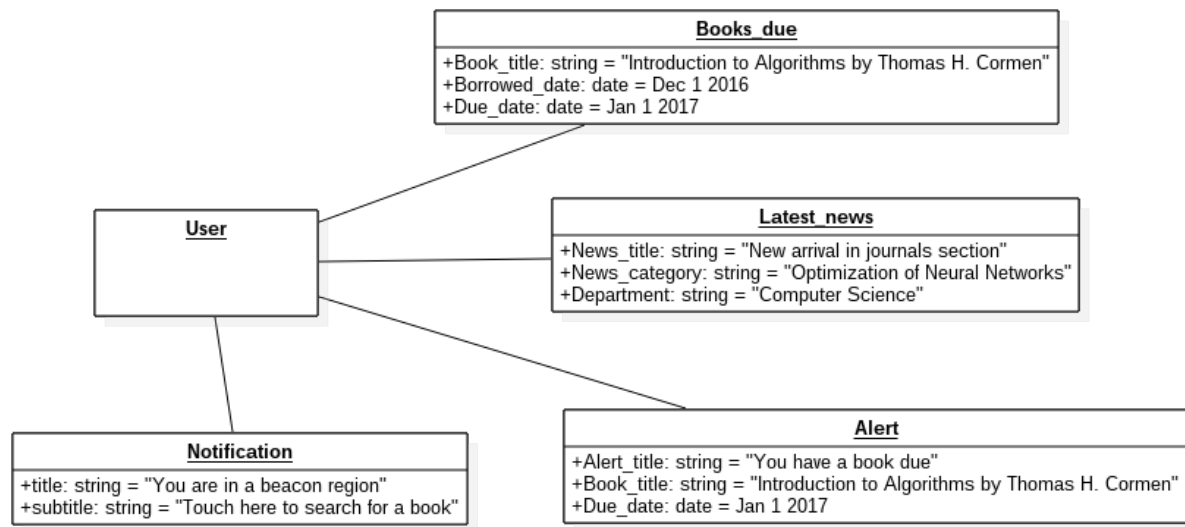# 2. DESIGN

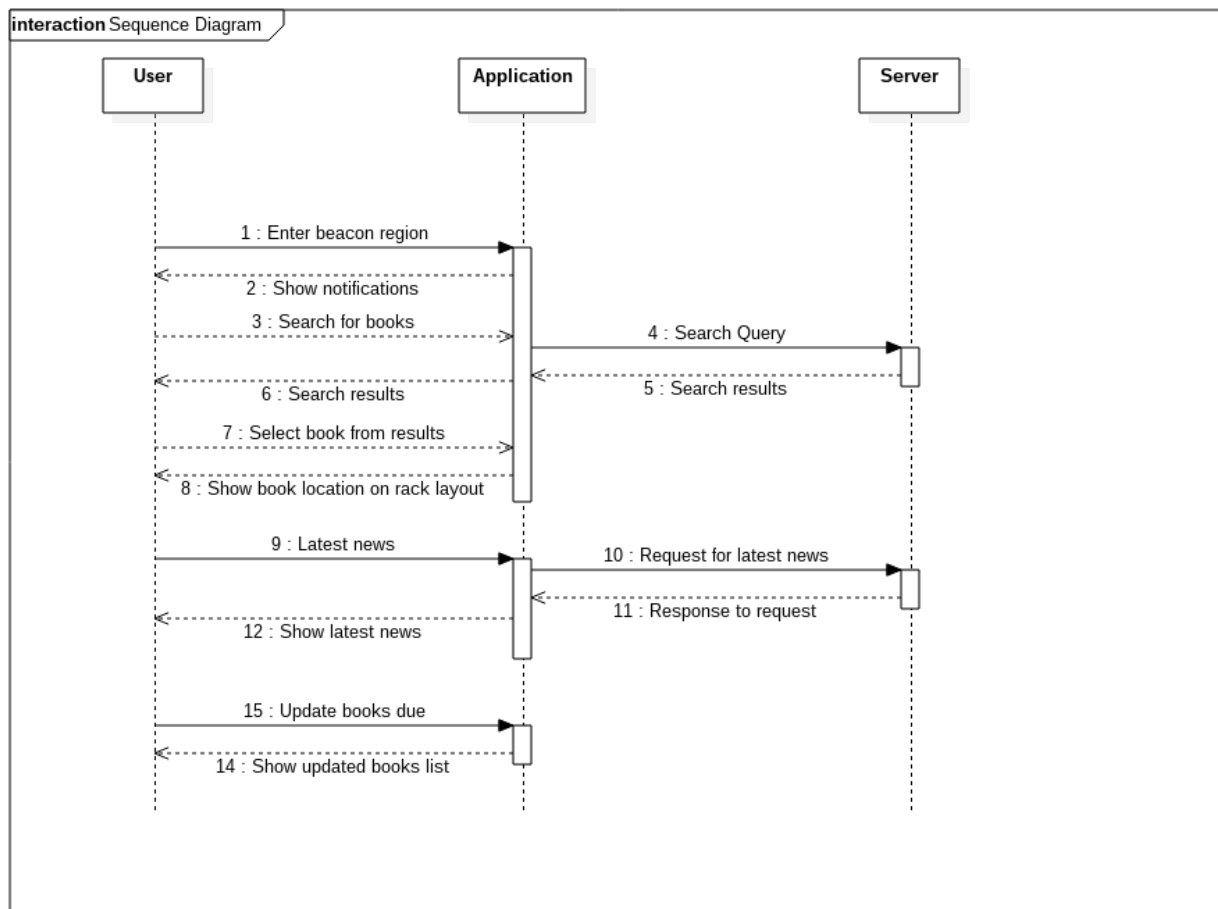## 2.1 UML DIAGRAMS: (Object Oriented Designs)

2.1.1 ER Diagram

2.1.2 Class Diagram

2.1.3 Object Diagram

Books_due
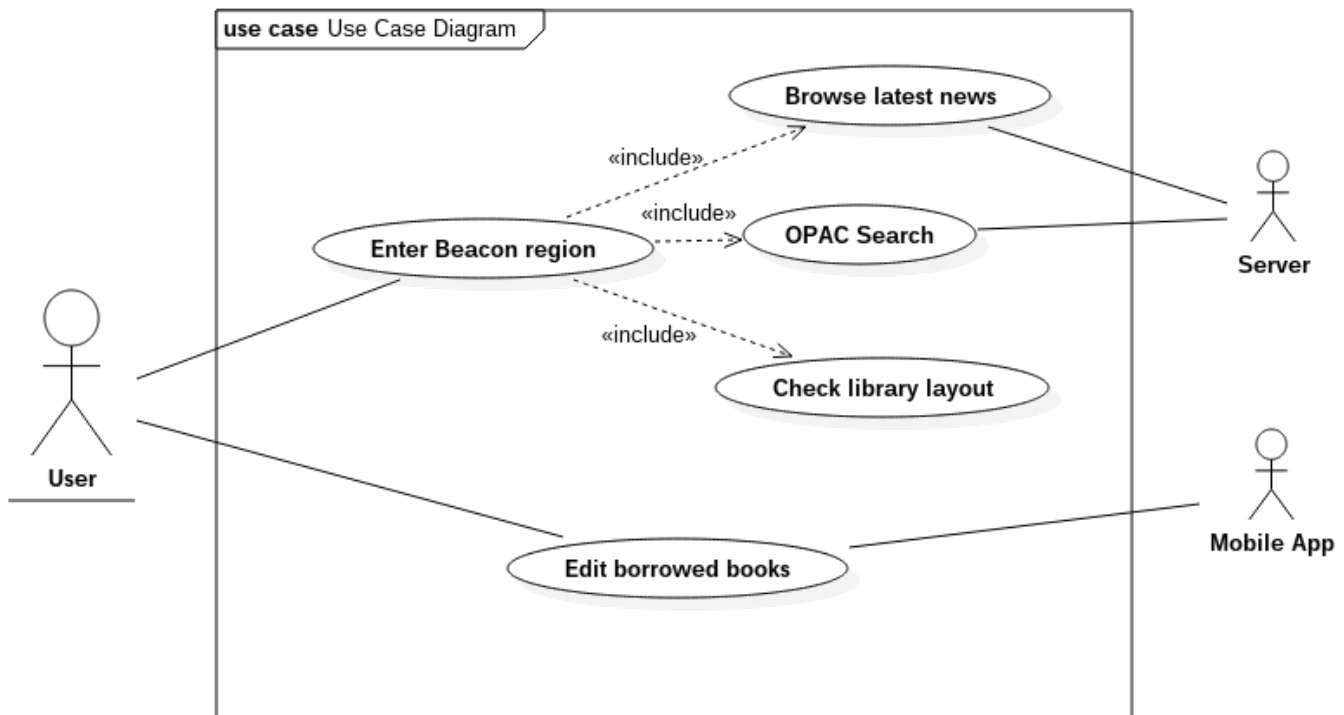+Book_title: string = "Introduction to Algorithms by Thomas H. Cormen"
+Borrowed_date: date = Dec 1 2016
+Due_date: date = Jan 1 2017

User

Latest_news
+News_title: string = "New arrival in journals section"
+News_category: string = "Optimization of Neural Networks"
+Department: string = "Computer Science"

Notification
+title: string = "You are in a beacon region"
+subtitle: string = "Touch here to search for a book"

Alert
+Alert_title: string = "You have a book due"
+Book_title: string = "Introduction to Algorithms by Thomas H. Cormen"
+Due_date: date = Jan 1 2017

2.1.4 Sequence Diagram

interaction Sequence Diagram

User   Application   Server

1 : Enter beacon region

2 : Show notifications

3 : Search for books

4 : Search Query

5 : Search results

6 : Search results

7 : Select book from results

8 : Show book location on rack layout

9 : Latest news

10 : Request for latest news

11 : Response to request

12 : Show latest news

15 : Update books due

14 : Show updated books list

2.1.5 Communication Diagram
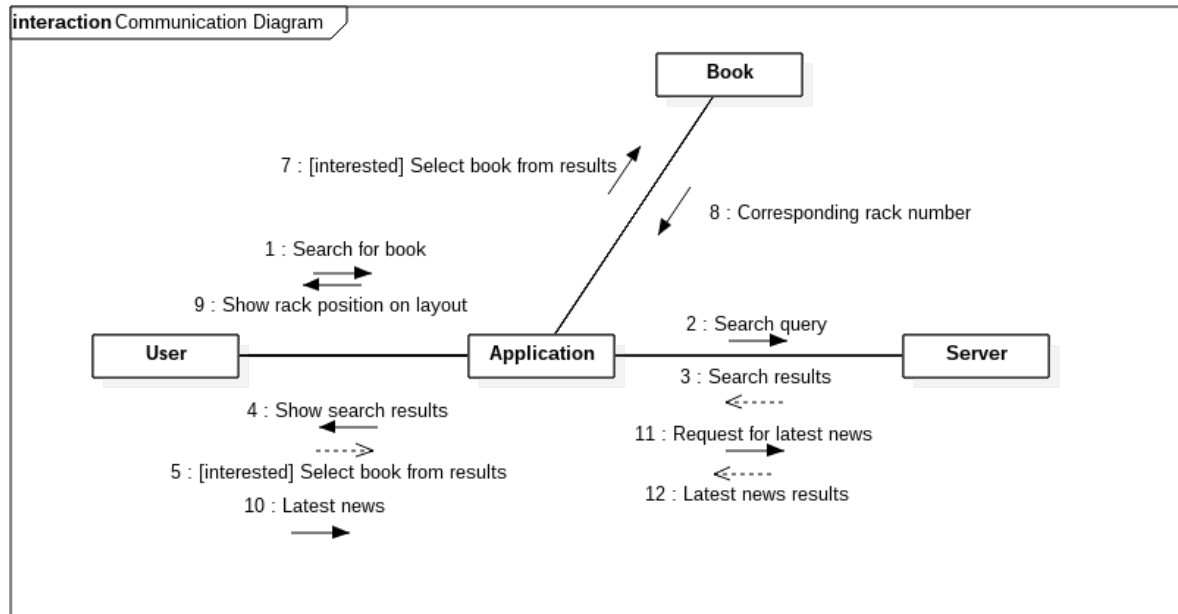
2.1.6 Use Case Diagram

2.2 DATABASE SCHEMA:

2.2.1 Table: **Borrowed books**

Book Title	Borrowed Date	Due Date

The database has only one table to store the books borrowed by the user. This database is stored on the mobile device's local storage.

3. IMPLEMENTATION DETAILS

The mobile application which is available for Android and iOS devices, has three main functionalities namely - Search for a book, select a book and see it's location, browse through latest feed and editing the list of borrowed books.

3.1 Major Functionalities:

3.1.1 Search for a book

The option for searching for a book is available on the home screen of the application and can be accessed by navigating to the corresponding tab. The user would have to enter a search query that could be a combination of the words in the book's name, author's name, subject and other fields, just like he would have to, in the OPAC search system in the library. He would then be shown a list of relevant books. On selecting a book, a map of the corresponding stack room where the book's rack is located is highlighted and is shown to the user.

There are three stack rooms in the library, one in the ground floor and two in the first. With the rack number, the application would search through the racks in all the stack rooms and show the user the stack room's layout where the book is located.

The search works by crawling the OPAC system search results, running on KOHA, an open-source integrated library system. The search crawler runs on a local server and is requested for results whenever a user searches for a book. It then queries the OPAC search server for the results, crawls and does processing on these results and returns them to the mobile application in a JSON

(JavaScript Object Notation) encoded format which can then be decoded by the mobile application.

3.1.2 Browse through latest feed

When the user enters the vicinity of the beacons with the application installed on his device, he would receive a notification to see through the latest news / arrivals in the library. The same could also be accessed via the home screen by navigating to latest news tab. The user then can see the various journals / books that have been newly added, latest events and other updates in the library or the college in general.

For adding news about the latest news and updates, a portal has been developed, which is available to the administrator in the library. The administrator can add news via the portal and all the users visiting the library would be notified of the news via the application.
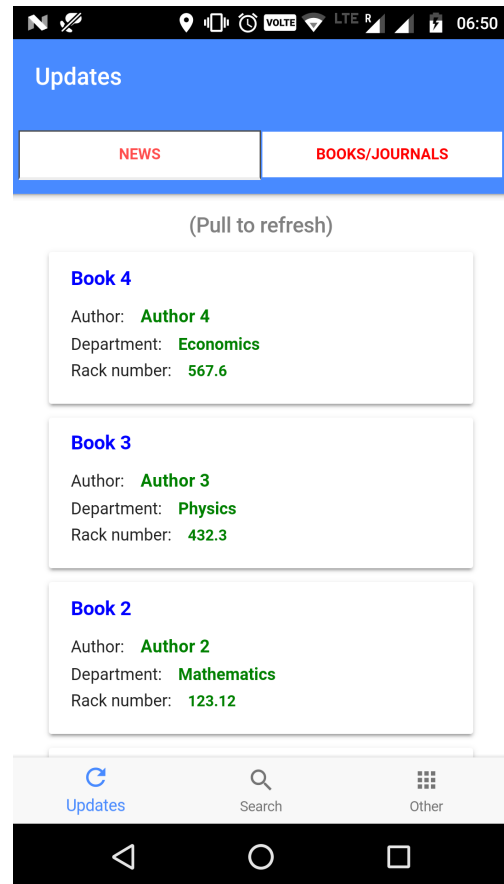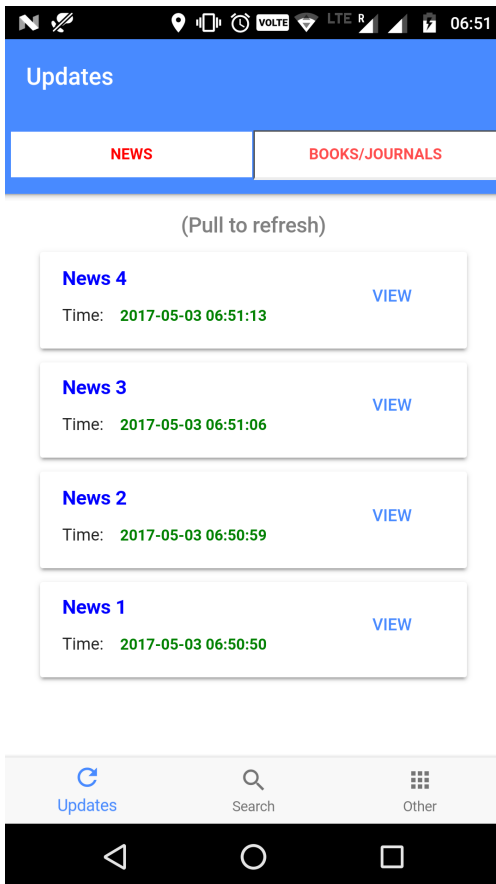
3.1.3 Edit borrowed books

This feature is to help the users keep track of the books they have borrowed and their due dates. The user's books are not stored on the server but locally on the mobile application. The user would be able add a book to the list

when he borrows a book from the library and delete it when he has returned the book.

3.2 Deployment details:

3.2.1 Search crawler

The search crawler has been deployed on a local server in the 'Software Systems Laboratory', IT Complex - 'Minerva' (IP: 192.168.40.103) and the crawler is accessible via the url - 'http://minerva.nitc.ac.in/libraryapp/?q=query'.

Every time the user searches for a book, the server receives the request, crawls the library OPAC server for results, and returns the encoded results to the application.

3.2.2 Web interface for latest news

The web interface, which is available to the administrator in the library is a simple web application, that has been deployed on the same Minerva server

3.2.3 Mobile application

There is an iOS and an Android implementation of the application. The android application is deployed to the Google play store. The app is available for free and can be downloaded from the play store via the link - "https:// play.google.com/store/apps/details?id=com.ionicframework.nitclibrary997380". The iOS application has not been yet deployed to the app store .

3.3 Technology Stack:

The entire project source codebase is public and is accessible via the link - "https://github.com/azharullah/NitcLibrary".

3.3.1 Mobile application

The mobile applications were developed using a framework named "IONIC". It is a free and open-source, cross-platform mobile application development framework which builds platform-specific applications from a single codebase developed in common web-programming-like languages. The version 2 of the framework, that uses Angular 2 and Typescript ES6 was used for developing the application.

The motive behind developing the application using this framework was to develop applications for both android and iOS platforms using a single codebase which makes it easy to develop, maintain and debug. Also ionic provides a lot of native plugins that lets the application access the device's native features like bluetooth, camera, location, etc.

3.3.2 Search crawler

The search crawler is developed in python, primarily because of the availability of 'Beautiful Soup', a python library for pulling data out of HTML and XML files. It parses the webpage as a DOM (Document Object Model) tree and navigates through the tree to find the required data from the webpage. This python script is executed through a PHP script running on the server. Every time a user searches for a book, the PHP script is called, it executes the python script and returns the details the books data in a JSON encoded format to the mobile application. The PHP and the python scripts are deployed in the Minerva server.

3.3.3 Web interface

The web interface is a simple web application developed using PHP and MySQL on the backend (also hosted on Minerva), AngularJS and MaterializeCSS on the frontend, that is available to the library administrator. The web application can be accessed via the URL - "http://minerva.nitc.ac.in/libraryapp/admin/"
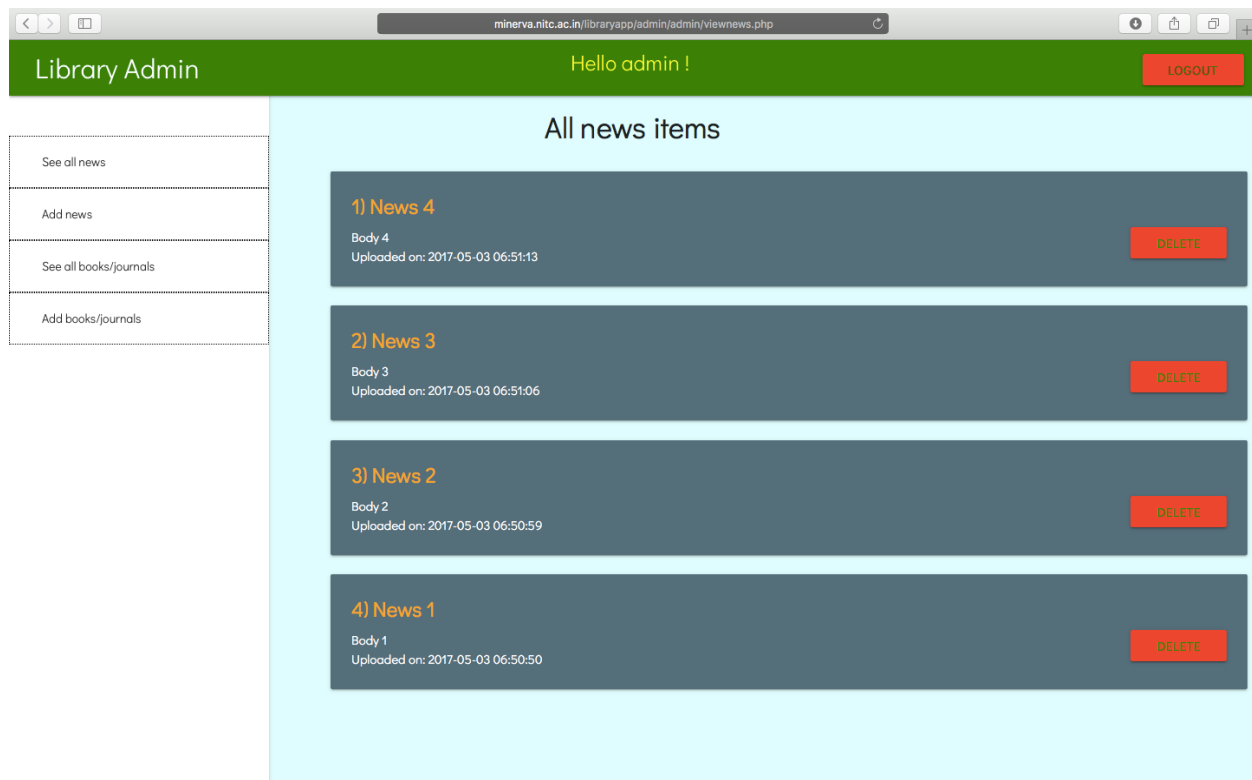
Web interface for the library administrator

3.3.4 Map layouts

The stack room layouts are simple webpages developed using AngularJS and jQuery for efficient searching for racks and highlighting the corresponding rack's location.

4. SYSTEM REQUIREMENTS

The application can efficiently run on any android device with an operating system version 4.1 and above. The iOS version of the application can run on any iOS device with operating system iOS 8 and above. The application requires a decent internet connection as the application requires to make calls to the server.

5. CONCLUSION

In this project, an effort was made to develop a mobile application for the benefit of the NITC community to solving a real-world existing problem - i.e. to make the process of borrowing a book from the central library as effortless and troublesome-free as possible. A relatively new and advanced 'beacon technology' is being used to solve this problem. This project is an effort to use technology to solve real world problems.

In the present scenario, a user intending to borrow a book from the library has to wait for his turn to search for a book on the OPAC search system in the stack room. Once he selects his required book, he is shown a rack number and he has to move around the library searching for the book / rack, which requires a lot of time and effort. Now, with the developed application, the user would be able to simply search for a book on his / her mobile device and on selecting a book, he would directly be shown the rack's location on a map so that he wouldn't have to remember the rack numbers. The application also provides the users information to the latest news and updates in the library and in the college in general.

NIT Calicut is probably one of the first educational institutions in India to have deployed this technology. There is still a very wide scope of use for this technology and could be further used to solve many problems in the real world.

6. REFERENCES

1. About the beacon technology - http://developer.estimote.com

2. Beginners guide to beacons - http://lighthouse.io/beginners-guide-to-beacons/

3. Libraries, beacons and IOT - https://www.ned-potter.com/blog/2526

4. Blog by Estimate on how beacons work. - http://blog.estimote.com/post/106913675010/how-do-beacons-work-the-physics-of-beacon-tech

5. Beacon technology deployed by libraries - http://blog.estimote.com/post/106913675010/how-do-beacons-work-the-physics-of-beacon-tech

6. Ionic framework - http://ionicframework.com

7. Cordova beacons plugin - http://ngcordova.com/docs/plugins/beacon/