# University of Ottawa

# GNG 2101 B03: Intro to Product Development and Management for Engineers

## Deliverable F: Prototype 2

Submitted by

Polaris, Team 33

Aymane Aziz, 300193353

Kevin Tu, 300188166

Julio Midence, 300170486

Aidan Billou, 300199731

Joon Lee, 300184520

Mana Azarm

David Londono

November 11, 2021

University of Ottawa

# ABSTRACT

This document will outline the work needed and the work done towards the creation of the team's second prototype. The goal of these prototypes is to create a finalized product which will guide users through the uOttawa library without assistance. The product will be in the form of an application.

# LIST OF FIGURES

# LIST OF TABLES

# TABLE OF CONTENTS

## 1.0 INTRODUCTION

This document will entail the design and testing for prototype two. Prototype two was well on its way to being finalized as soon as prototype one was finished. The biggest challenge and milestone was testing the accuracy of the bluetooth signal the team will be using. The team wanted to test how accurate the Adruino Nano/beacon is able to send out bluetooth signals. After the submission of Deliverable D where the details for prototype one can be found, the team worked on a progress presentation to show to the client. A third client meeting was held and the client was happy with the progress the team had made.

## 2.0 CLIENT FEEDBACK

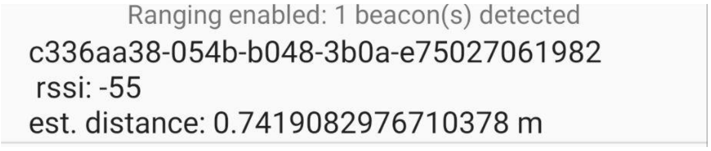
The team started working on prototype two as soon as prototype one was completed and handed in. There was some time between the completion of prototype one and the third client meeting. The team was referring back to Deliverable B in order to see the target specifications and the client needs to continue working on Prototype two. The prototype at the moment was shown to the client during the third meeting and the client was very happy with the work done. The client said the team was well underway to having a finalized product with all the requirements. Questions were made about the specific functions such as user interface and the announcements page to which the client stated that no changes needed to be made. The team will continue to refer back to Deliverable B to check the client needs in order to keep the prototypes in check. The biggest client need the team will consider will be the user interface as it is ranked the most important in the previous deliverables.

## 3.0 PROTOTYPE 2

The second prototype of the Northstar application consists mainly of the testing of the bluetooth signals and the addition of announcements in the admin page. There are more features that have not been completely finalized but will be shortly. These features include the integration of a French translator for those part of the francophone communities, a birds eye view of the library and many others.

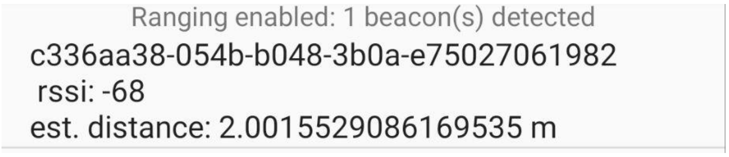
### 3.1 Testing Accuracy Of Bluetooth

The accuracy of the bluetooth signals is one of the most important aspects of the Northstar application. Microcontrollers were used to output the signals. The Arduino Nano acts as the beacon and an Android mobile device detects the signals and prints out the distance in meters. Eight different tests were performed to test out the accuracy of the signals. The beacon was placed at four different lengths from the mobile device, 0.5m, 1.0m, 2.0m, 4.0m. For each length, the accuracy was tested without any obstacles in the way of the devices, and with a person standing between the devices at an equal distance from both the mobile device and the beacon. The figures below demonstrate the accuracy of the bluetooth signals at the different lengths.



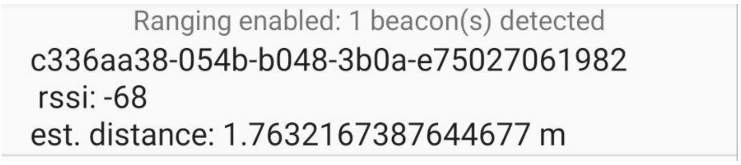
Ranging enabled: 1 beacon(s) detected
c336aa38-054b-b048-3b0a-e75027061982
rssi: -55
est. distance: 0.7419082976710378 m

**Figure 1. 0.5m without obstruction**



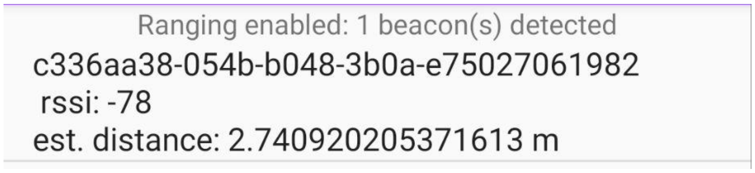
Ranging enabled: 1 beacon(s) detected
c336aa38-054b-b048-3b0a-e75027061982
rssi: -68
est. distance: 2.0015529086169535 m

**Figure 2. 0.5m with obstruction in line of sight halfway**



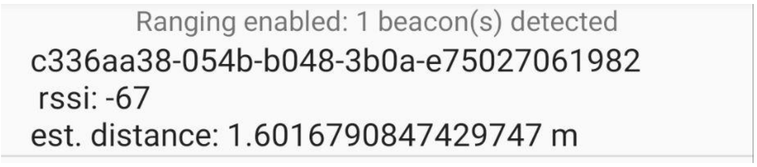
Ranging enabled: 1 beacon(s) detected
c336aa38-054b-b048-3b0a-e75027061982
rssi: -68
est. distance: 1.7632167387644677 m

**Figure 3. 1.0m without obstruction**



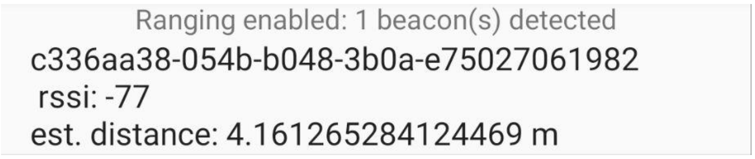
Ranging enabled: 1 beacon(s) detected
c336aa38-054b-b048-3b0a-e75027061982
rssi: -78
est. distance: 2.740920205371613 m

**Figure 4. 1.0m with obstruction in line of sight halfway**



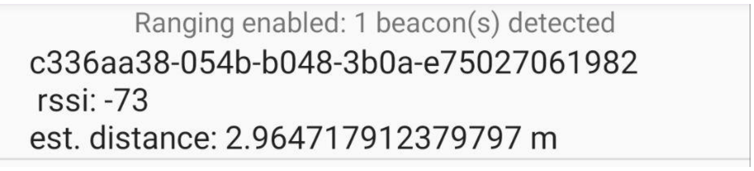
Ranging enabled: 1 beacon(s) detected
c336aa38-054b-b048-3b0a-e75027061982
rssi: -67
est. distance: 1.6016790847429747 m

**Figure 5. 2.0m without obstruction**



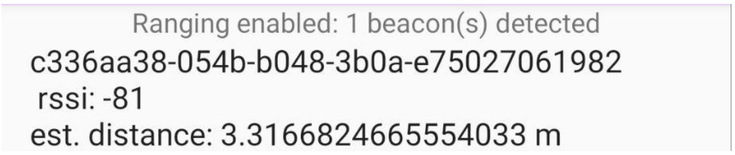
Ranging enabled: 1 beacon(s) detected
c336aa38-054b-b048-3b0a-e75027061982
rssi: -77
est. distance: 4.161265284124469 m

**Figure 6. 2.0m with obstruction in line of sight halfway**


Ranging enabled: 1 beacon(s) detected

c336aa38-054b-b048-3b0a-e75027061982
rssi: -73
est. distance: 2.964717912379797 m

**Figure 7. 4.0m without obstruction**


Ranging enabled: 1 beacon(s) detected

c336aa38-054b-b048-3b0a-e75027061982
rssi: -81
est. distance: 3.3166824665554033 m

**Figure 8. 4.0m with obstruction in line of sight halfway**

The table below shows a summary of the results from the figures above. The values on the left show the measured distance between the Arduino Nano/Beacon and the mobile device. The remainder of the values show the calculated distance both with nothing blocking the signals and with a person between the two devices.

**Table 1. Summary of tests at various locations**

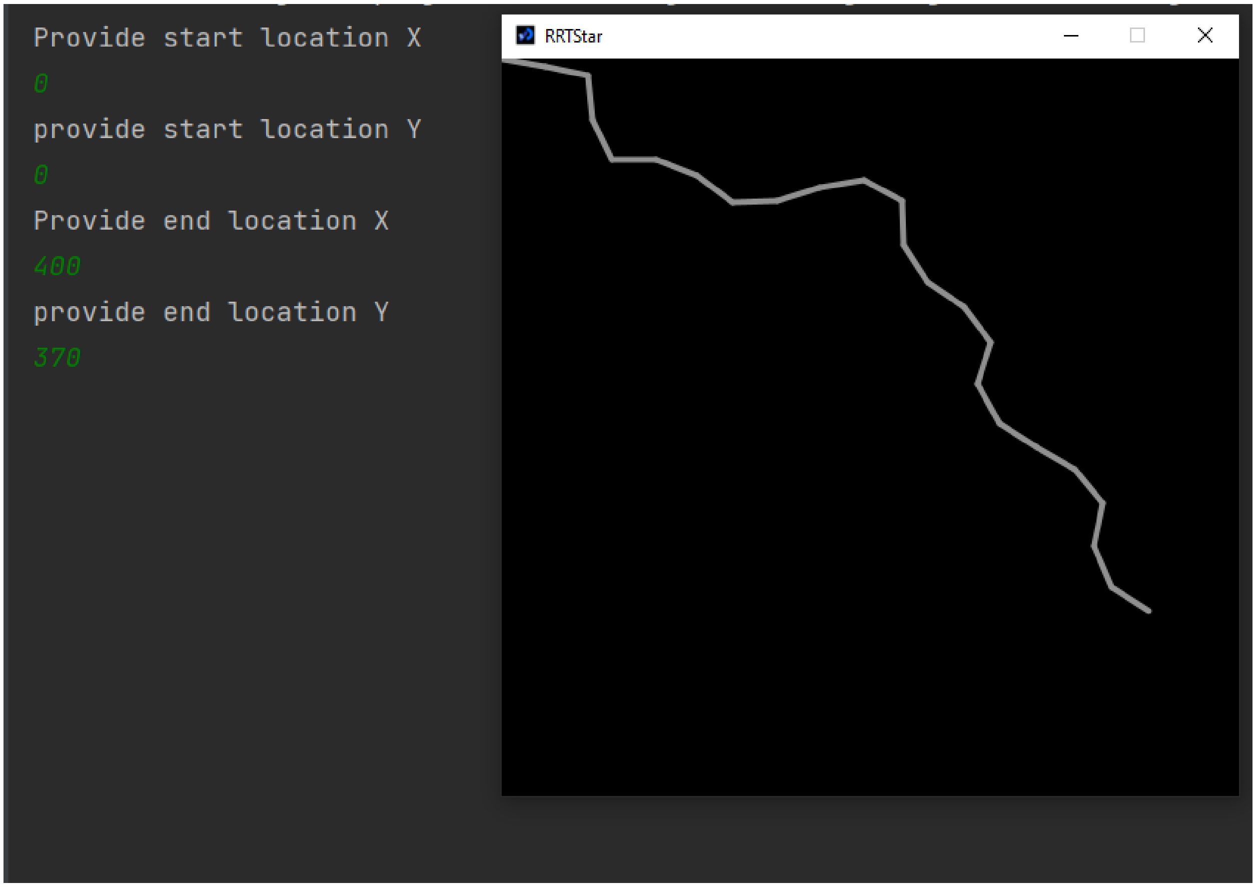
| Actual distance | No obstruction | Obstruction |
|---|---|---|
| 0.5m | 0.74m | 2.00m |
| 1.0m | 1.76m | 2.74m |
| 2.0m | 1.60m | 4.16m |
| 4.0m | 2.96m | 3.32m |

From this test, the accuracy was within 100cm at a distance of 4m. Using one beacon, it is very difficult to give an accurate reading of the user's location and small dips in the signal strength leads to a noticeable drop in accuracy of the distance. The program will use three beacons to better locate the user and provide accurate positioning of the user in the near future. A function will be implemented to prevent surges in distance, and triangulation of the user using three BLE beacons.

This tests the accuracy requirements as defined in our deliverable. Our results were all within 1m which is reasonable for the purpose of this application of guiding users to a specific area in the library, not to a specific section of a shelf such as a book. As previously mentioned, with additional beacons the accuracy will likely be narrowed down which will further improve the accuracy of the program.

## 3.2 Testing The Algorithm

The figure below shows the RRT pathfinding algorithm in action. It is a modified version of a RRT implementation by molinab297 which can be found at https://github.com/molinab297/RapidExploringRandomTree. This test was conducted to test the functionality and feasibility of our algorithm which extends our requirement of accuracy and user experience as mentioned in the previous deliverables. Having an algorithm that is able to give accurate and efficient path is a key feature of the application and an algorithm that is able to return a path quickly improves on the user experience.



```
Provide start location X
0
provide start location Y
0
Provide end location X
400
provide end location Y
370
```

**Figure 9. RRT algorithm testing**

The testing of the time was not conducted as it was instantaneous and measuring time in the range of microseconds is not significant to the user experience.

The library was modified such that it does not require a graphic user interface in order to add points and additional changes to the way it finds the closest nodes along with the random number generation for placing down points. The GUI shown above was created only for testing to ensure that the generated path is making it to the end point and will not be needed in the final version.

Unfortunately, the tests were not satisfactory as the path generated was inefficient and jagged. The major flaw with this implementation of the algorithm was that it did not allow for additional refinement of the path after it had first reached the end goal. Due to these disappointing results, another version of the algorithm is being worked on based on another library.

## 3.3 Adding Announcement

The "Add announcement" button has been implemented, when clicking it there is a popup window that shows up allowing the admin to write announcements and publish them. By clicking publish, the announcement is added to the local database and a message informs the user that it had been published successfully.

The figure below shows the implementation of the "Add announcement" button in the admin page.

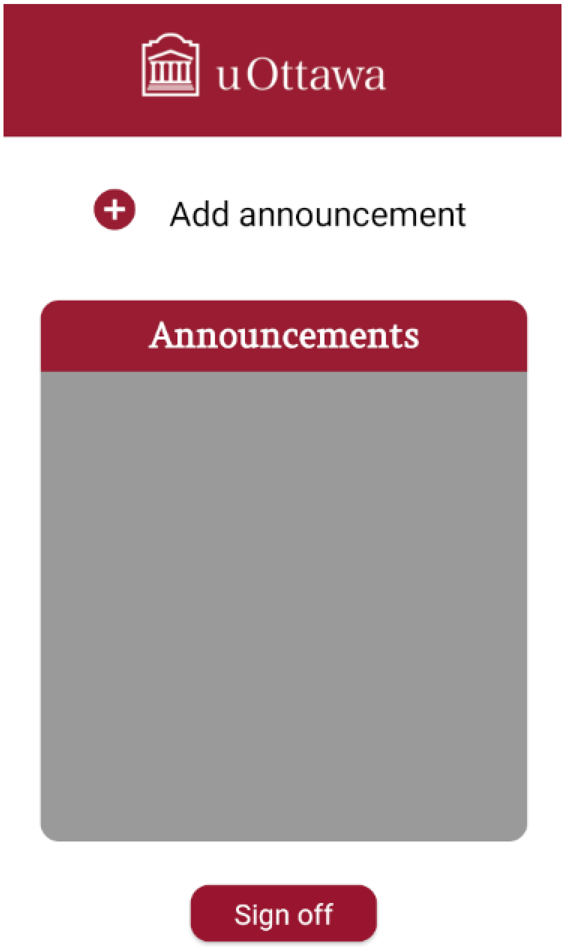


**Figure 10. Announcement Page**

The figure below shows the pop up window that appears after clicking the button, The admin has to write the announcement and then click “publish”.

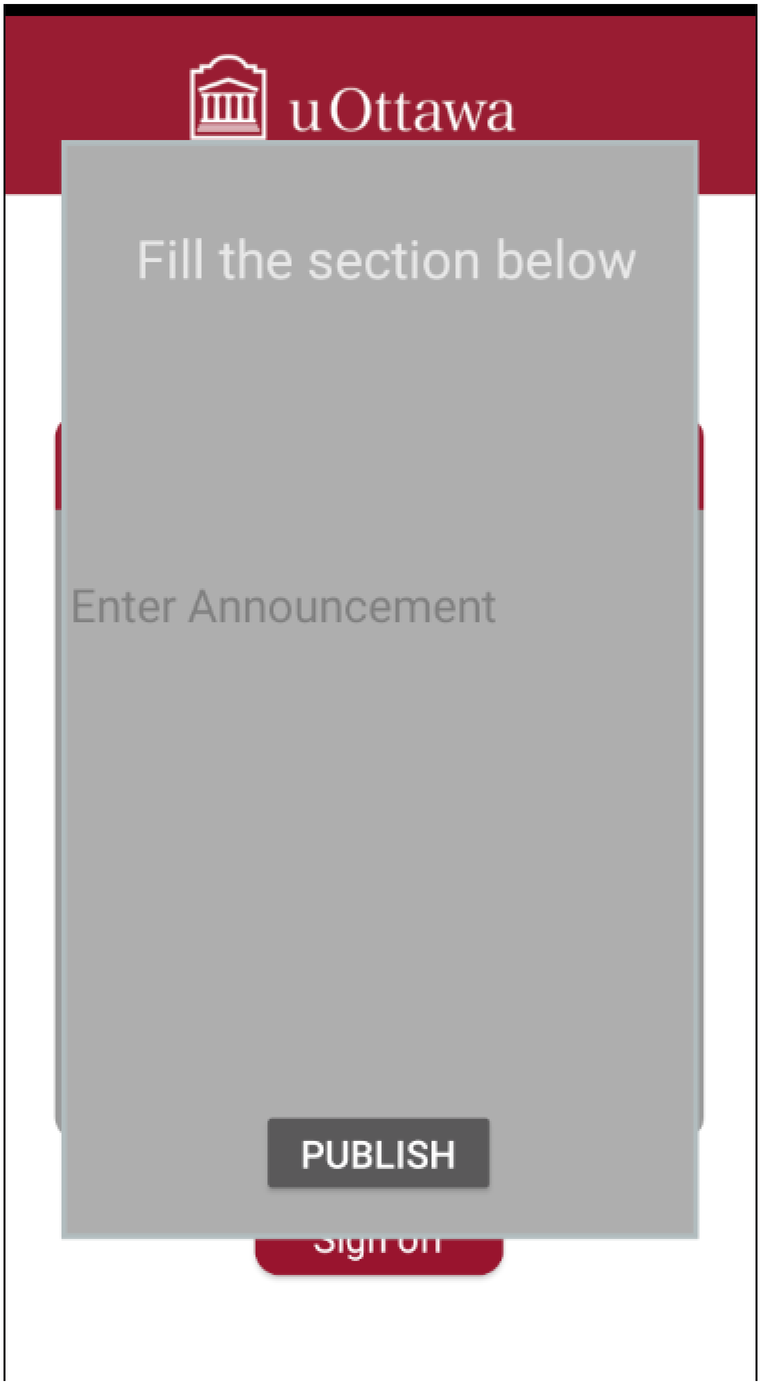
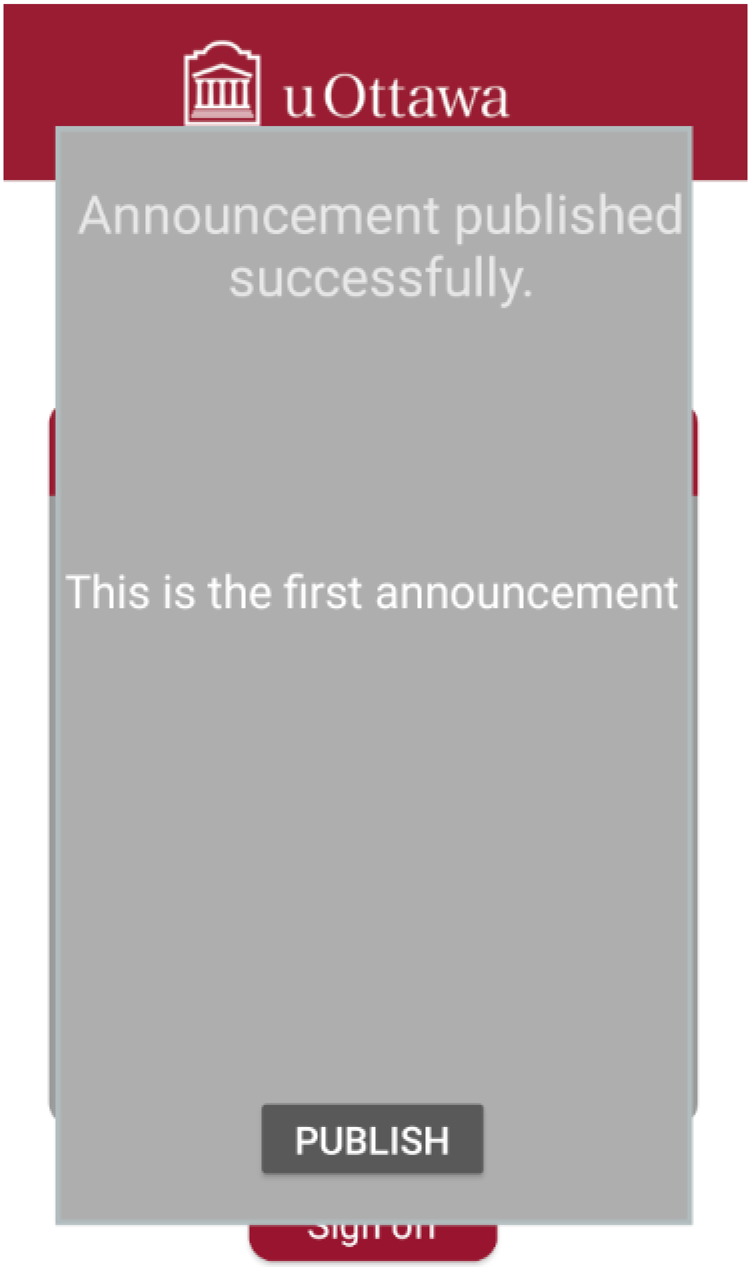


**Figure 11. Enter Announcement Page**

This figure shows the message informing the user that the announcement has been published successfully.

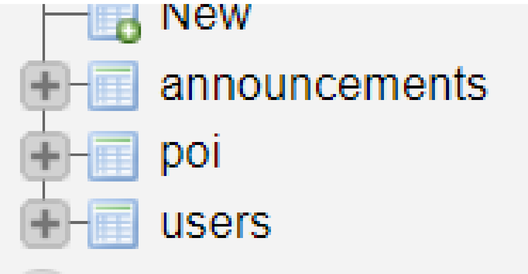


Announcement published successfully.

This is the first announcement

**Figure 12. Announcement Published Page**

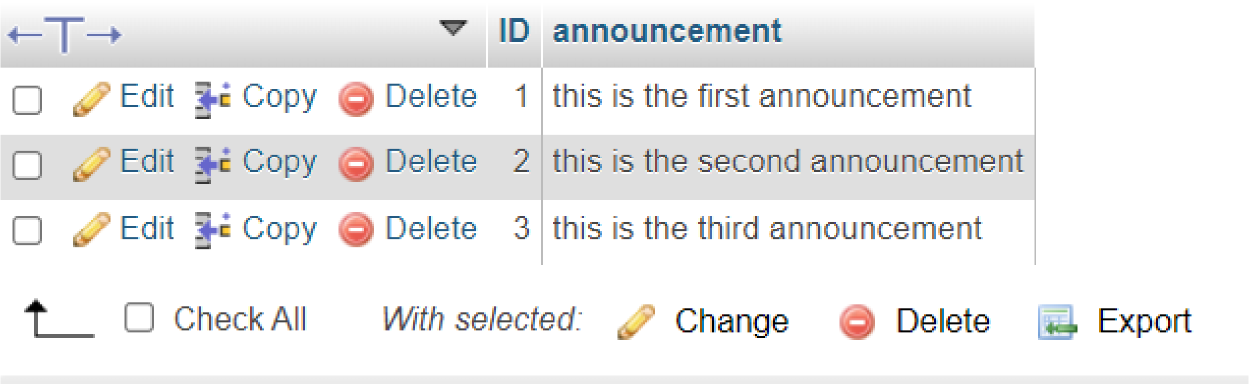
This figure shows the different tables of the local database including the announcements table.



New
announcements
poi
users

**Figure 13. Database structure**

This figure shows the announcement table where all the announcements made by the library are stored.



| ←T→ | ID | announcement |
|---|---|---|
| ☐ Edit Copy Delete | 1 | this is the first announcement |
| ☐ Edit Copy Delete | 2 | this is the second announcement |
| ☐ Edit Copy Delete | 3 | this is the third announcement |

**Figure 14. Database announcement organization**

## 4.0 CONCLUSION

The document has gone into depth of the design and testing for prototype two. The testing for the accuracy of the bluetooth signals was conducted and the results were satisfactory. The results were accurate for the intended purpose of the product. The Northstar application is intended to guide users to specific locations in the library rather than specific areas of a shelf such as a book. The future steps for the testing of the beacon and or signal accuracy is to incorporate more Arduino Nanos in order to triangulate the position of the user. The program to triangulate a device is under production and will be available for the finalized product. The team will continue to refer back to Deliverable B to check in with the most important client needs such as user interface, accuracy and ease of use. With these target specifications in mind, the team will continue to work on the application and satisfy the client.