

Indoor Localisation Documentation

Connect to EC2 Instance

Pre-requisites:

- Ensure the EC2 instance is turned on
- Ensure you have the keypair (Jerm2020_firstpair.pem)
- Domain name license is valid

Procedure

- remote ssh into the EC2 instance by running

```
ssh -i "Jermyn_secondpair2020.pem" ec2-user@ec2-52-77-184-100.ap-southeast-1.compute.amazonaws.com (mailto:ec2-user@ec2-52-77-184-100.ap-southeast-1.compute.amazonaws.com)
```

- Do ensure that you run this command in the same directory of the keypair

```
Last login: Fri Oct  7 12:49:12 on console
You have new mail.
Welcome to fish, the friendly interactive shell
> ~ cd Desktop/eclipse-workspace/aws
> ~/D/e/aws ssh -i "Jermyn_secondpair2020.pem" ec2-user@ec2-52-77-184-100.ap-southeast-1.compute.amazonaws.com
```

- You should see the following:

```
Last login: Fri Oct  7 12:49:12 on console
You have new mail.
Welcome to fish, the friendly interactive shell
> ~ cd Desktop/eclipse-workspace/aws
> ~/D/e/aws ssh -i "Jermyn_secondpair2020.pem" ec2-user@ec2-52-77-184-100.ap-southeast-1.compute.amazonaws.com
Last login: Fri Sep 23 04:23:46 2022 from 137.132.234.27

      _\   _ ) 
     _ \  /  Amazon Linux 2 AMI
    ___\_\_|___| 

https://aws.amazon.com/amazon-linux-2/
-bash: warning: setlocale: LC_CTYPE: cannot change locale (UTF-8): No such file or directory
manpath: can't set the locale; make sure $LC_* and $LANG are correct
[ec2-user@ip-10-0-12-15 ~]$
```

Running all Server Scripts (if they are not run or have errors - can skip this if all are ok)

Postgres Server

- Ensure AWS Postgres RDS is turned on
- run

pm2 start postgres

- Check you can load loopback explorer and graphql
- run "52.77.184.100:3000/explorer" on the browser

The screenshot shows the StrongLoop API Explorer interface. At the top, there's a navigation bar with a back arrow, forward arrow, and a search bar containing 'Not Secure — 52.77.184.100:3000/explorer/#/'. Below the bar, there's a header with the StrongLoop logo and the text 'StrongLoop API Explorer'. A token input field says 'Token Not Set' with a placeholder 'accessToken' and a 'Set Access Token' button. The main content area is titled 'api-server' and lists several endpoints with their operation details:

Endpoint	Show/Hide	List Operations	Expand Operations
Anchor	Show/Hide	List Operations	Expand Operations
Beacon	Show/Hide	List Operations	Expand Operations
Device	Show/Hide	List Operations	Expand Operations
Gatt	Show/Hide	List Operations	Expand Operations
Map	Show/Hide	List Operations	Expand Operations
User	Show/Hide	List Operations	Expand Operations

At the bottom of the content area, it says '[BASE URL: /api , API VERSION: 1.0.0]'

- type "52.77.184.100:3000/graphql" on the browser

The screenshot shows the GraphiQL interface. At the top, there's a navigation bar with a back arrow, forward arrow, and a search bar containing 'Not Secure — 52.77.184.100:3000/graphql/'. Below the bar, there's a toolbar with buttons for 'GraphiQL', 'Prettify', 'Merge', 'Copy', and 'History'. The main content area contains a code editor with a sample GraphQL query:

```

1 # Welcome to GraphQL
2 #
3 # GraphQL is an in-browser tool for writing, validating, and
4 # testing GraphQL queries.
5 #
6 # Type queries into this side of the screen, and you will see intelligent
7 # typeahead aware of the current GraphQL type schema and live syntax and
8 # validation errors highlighted within the text.
9 #
10 # GraphQL queries typically start with a "{" character. Lines that start
11 # with a # are ignored.
12 #
13 # An example GraphQL query might look like:
14 #
15 #   {
16 #     field(arg: "value") {
17 #       subField
18 #     }
19 #   }
20 #
21 # Keyboard shortcuts:
22 #
23 # Prettify Query: Shift-Ctrl-P (or press the prettify button above)
24 #
25 # Merge Query: Shift-Ctrl-M (or press the merge button above)
26 #
27 # Run Query: Ctrl-Enter (or press the play button above)
28 #
29 # Auto Complete: Ctrl-Space (or just start typing)
30 #
31
32

```

Notification Server

- run

pm2 start coffee

- Check that "server heartbeat" or some anchor status is being logged in the coffee logs
- Ensure no errors are being logged
- run

pm2 monit

- and check the logs of coffee script

```

Process List
[ 2] barycentric      Mem:  0 MB CPU:  0 % stopped
[ 6] barycentric_AR   Mem:  0 MB CPU:  0 % stopped
[ 0] coffee           Mem: 64 MB CPU:  0 % online
[ 4] dashboard         Mem:  0 MB CPU:  0 % stopped
[ 4] devWeb           Mem:  0 MB CPU:  0 % stopped
[ 9] jupyter-documentation Mem: 69 MB CPU:  0 % o
[ 1] jupyter-notebook    Mem: 16 MB CPU:  0 % stoppe
[ 5] postgres          Mem: 148 MB CPU:  0 % online

coffee > gatts: { connected: [] }
coffee > 
coffee > Sending anchor status of rpi4...
coffee > ANCHOR_STATUS {
coffee >   address: '00:27:eb:fd:8f:8d'
coffee >   syslog: '/var/log/syslog'
coffee >   address: '00:27:eb:fd:8f:8d\n',
coffee >   hciconfig: 'hciconfig: ttyp0: Primary Bus: UART\n' +
coffee >   '\tBD Address: 00:27:EB:8D:70:72 ACL MTU: 1021:8 SCO MTU: 64:1\n' +
coffee >   '\tUP RUNNING Va...
coffee >   '\tRX bytes:2053785287 acl:0 sco:0 events:531185401 errors:0\n' +
coffee >   '\tTX bytes:342368 acl:0 sco:0 commands:392933 errors:0\n' +
coffee >   '\n',
coffee >   ifconfig: 'wlan0: flags=16343UP,BROADCAST,RUNNING,MULTICAST  mtu 1500\n' +
coffee >   '      inet 172.23.74.131 brd 255.255.252.0 broadcast 172.23.75.255\n' +
coffee >   '      netmask 255.255.252.0 brd 255.255.252.0 prelink off scopeid 0x20<brink>\n' +
coffee >   '      ether 00:27:eb:fd:8f:8d brd ff:ff:ff:ff:ff:ff linklayer [ether]\n' +
coffee >   '      RX packets 25586883 bytes 1043426682 (995.0 MiB)\n' +
coffee >   '      RX errors 0 dropped 4927 overruns 0 frame 0\n' +
coffee >   '      TX packets 26994326 bytes 263711443 (2.4 GiB)\n' +
coffee >   '      TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0\n' +
coffee >   '\n',
coffee >   iwconfig: 'wlan0 IEEE 802.11 ESSID:"NUS"  \n' +
coffee >   '      Mode:Managed Frequency:2.412 GHz  Access Point: 0C:D1:E0:DF:F3:40  \n' +
coffee >   '      Bit Rate=26 Mb/s Tx-Power=31 dBm  \n' +
coffee >   '      Retry short limit:7 RTS thr:off  Fragment thr:off\n' +
coffee >   '      Encryption key:off\n' +
coffee >   '      Power Management:on\n' +
coffee >   '      Link Quality=72/79 Signal level=-79 dBm  \n' +
coffee >   '      Rx invalid nwid:0 Rx invalid crypt:0 Rx invalid frag:0  Missed beacon:0\n' +
coffee >   '      Tx excessive retries:1977  Invalid misc:0  Missed beacon:0\n' +
coffee >   '\n',
coffee >   iproute: 'default via 172.23.72.1 dev wlan0 src 172.23.74.131 metric 302 \n' +
coffee >   'dev wlan0 172.23.72.1  brd 172.23.72.255  src 172.23.74.131 metric 302 \n',
coffee >   'ip: 172.23.74.131',
coffee >   host: 'pi47un',
coffee >   },
coffee >   anchorId: 'b6827ebfd8f8d',
coffee >   hostname: 'pi47un',
coffee >   gatts: { connected: [] }
coffee >   Sending anchor status of rpi4...
coffee >   sending heartbeat

Custom Metrics
Heap Size          13.46 MiB
Heap Usage          99.13 %
Used Heap Size     12.31 MiB
Active requests    0
Active handles     3
Event Loop Latency 0.23 ms
Event Loop Latency p95 1.02 ms

Metadata
App Name           coffee
Namespace          default
Version            1.0.0
Restarts           1
Uptime              28s
Script path        /data/vac/www/html/indoor-localisation-2.0/server/notification-server/server.js
Script args         N/A
Interpreter        node
Interpreter args   N/A
Exec mode          fork
Node.js version    16.7.0
watch & reload     *
Unstable restarts  0
Comments           N/A

left/right: switch boards | up/down/mouse: scroll | Ctrl-C: exit
To go further check out https://pm2.io/

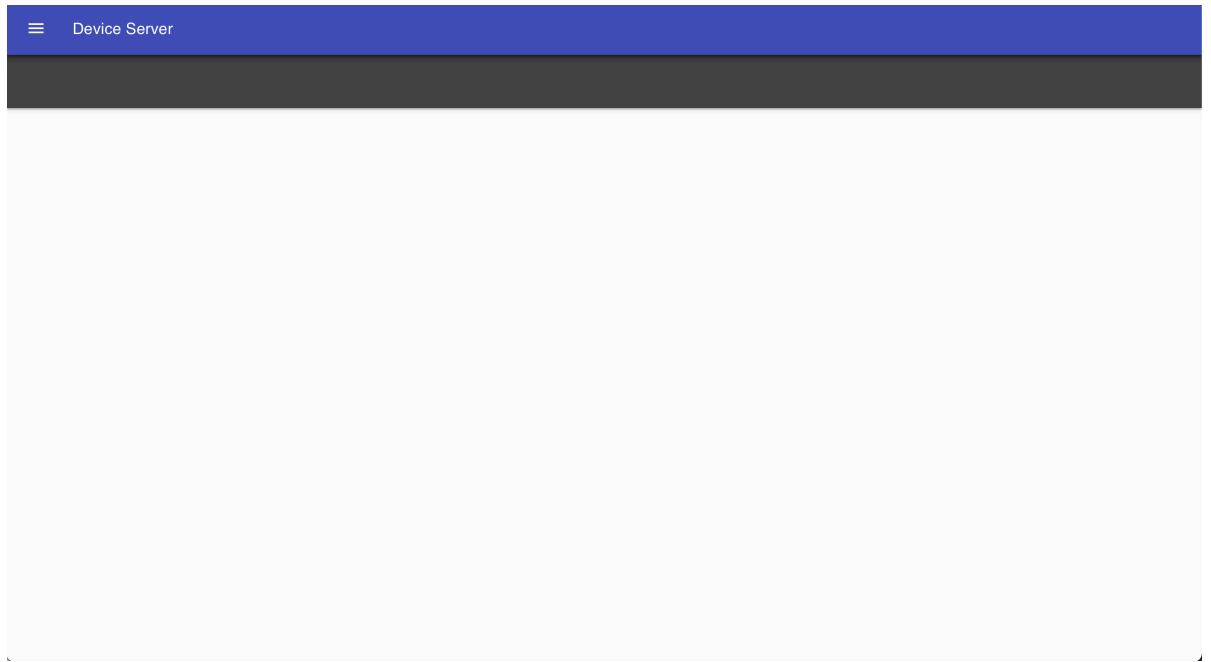
```

Developer's Web Server

- run

pm2 start devWeb

- Check the web server runs normally
- type "52.77.184.100:3001" on your browser to load the website



- check the devices page is load normally
- if this page is not loaded properly, it is either the RDS is not turned on or the web backend has some errors

The screenshot shows the "STATIC DEVICES" tab selected in the navigation bar. Below the header, there is a table with columns: id, anchorId, sensitivity, beaconId, measuredPower, offset, location, and actions. The table contains data for various anchors, including their ID, location, and measured power levels. Each row has edit and delete icons in the "actions" column.

STATIC DEVICES							MOBILE DEVICES
							ADD +
id	anchorId	sensitivity	beaconId	measuredPower	offset	location	actions
100	100	0		-68.88	0		
A2	Ward2_Bed1	0		-61.03	0		
anchor1	Ward2_Bed6	0		-60	0	simulated dorms	
anchor2	107	0		-60	0	simulated dorms	
anchor3	Ward2_Bed5	0		-61	0		
anchor4	Ward1_Bed6	0		-60	0		
anchor5	Corridor7	0		-60	0		
L	anchor6	Corridor3		-63.93	0		

ELK Server

- run

`sudo systemctl start elasticsearch logstash kibana`

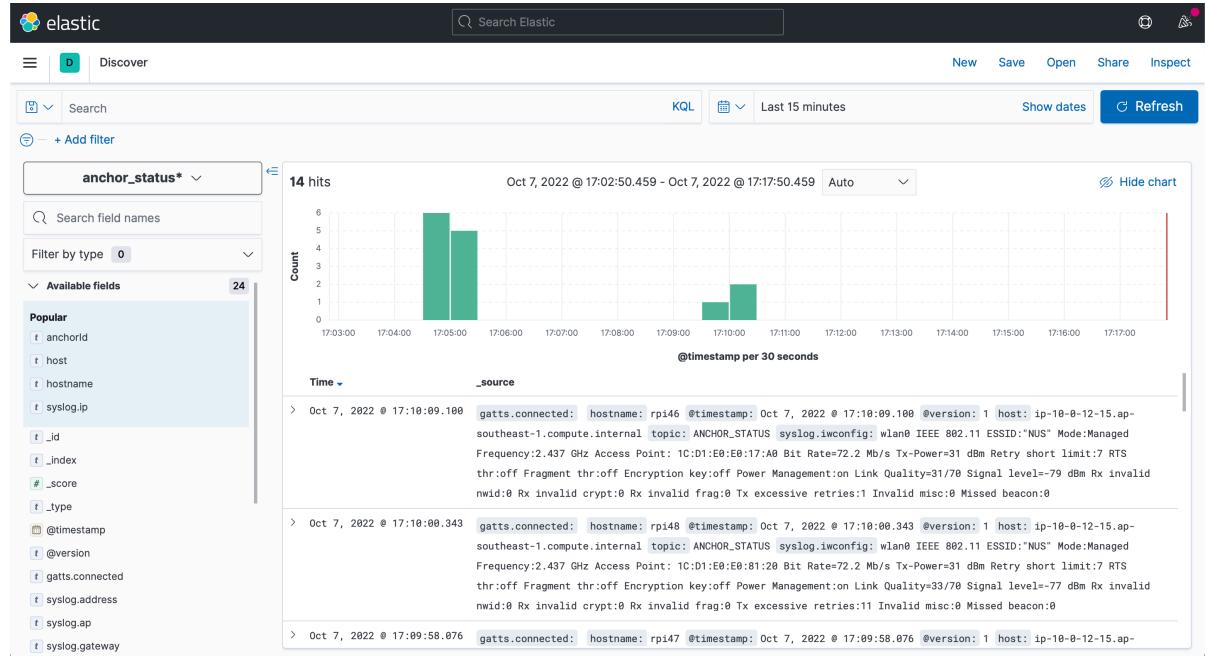
- check the status of each by running

`sudo systemctl status elasticsearch logstash kibana`

- ensure all are running. They should state running with a green color indicator, as shown below

```
[ec2-user@ip-10-0-12-15 documentation]$ sudo systemctl status elasticsearch
● elasticsearch.service - Elasticsearch
   Loaded: loaded (/etc/systemd/system/elasticsearch.service; enabled; vendor preset: disabled)
   Active: active (running) since Fri 2022-09-23 02:39:48 UTC; 2 weeks 0 days ago
     Docs: https://www.elastic.co
 Main PID: 2580 (jboss)
   CGroup: /system.slice/elasticsearch.service
           └─2586 /data/usr/share/elasticsearch/jdk/bin/java -Xshare:auto -Des.networkaddress.cache.ttl=60 -Des.networkaddress.cache.negative.ttl=10 -XX:+AlwaysPreTouch -Xss1m -Djava.awt.he...
```

- check the kibana website to confirm the ELK server is running properly
- type "52.77.184.100:5601" in the browser



Raspberry Pi

- enter into node_client directory
 - run

sudo systemctl start pulse

- Check the rpis are detected by the server via the kibana->visualise->Anchor Status as shown below

The screenshot shows the Elastic Visualize interface. The top navigation bar includes the elastic logo, a search bar labeled "Search Elastic", and a "Visualize" tab. On the right, there are buttons for "Download as CSV" and "Save". Below the navigation, there's a search bar with a dropdown icon and the text "Search", followed by a "KQL" button and a time range selector "Last 15 minutes". To the right are buttons for "Show dates" and "Refresh".

The main area has a sidebar on the left with a search bar for "anchor_status*" and a "Field filters" section showing 0 filters applied. Below these are sections for "Records" and "Available fields", listing fields like @timestamp, @version.keyword, anchorid.keyword, host.keyword, hostname.keyword, syslog.address.keyword, syslog.ap.keyword, syslog.gateway.keyword, syslog.hci.keyword, and syslog.hciconfig.keyword.

The central part of the interface features a "Data table" section with a dropdown menu. The table displays four rows of data:

anchord	hostname	timestamp per 5 minutes ↓	ip
b827eb6ee1b3	rpi46	17:25	172.23.11.208
b827eb92ac17	rpi48	17:25	172.23.95.44
b827ebfd8f8d	rpi47	17:20	172.23.74.131

The right side of the interface contains two sections: "Break down by" and "Metrics". The "Break down by" section lists anchorid, hostname, and timestamp. The "Metrics" section lists ip. Both sections include a "Drop a field or click to add" placeholder and a "Reset layer" button.

Algorithm Server

- when the need arises to conduct localisation experiment, run

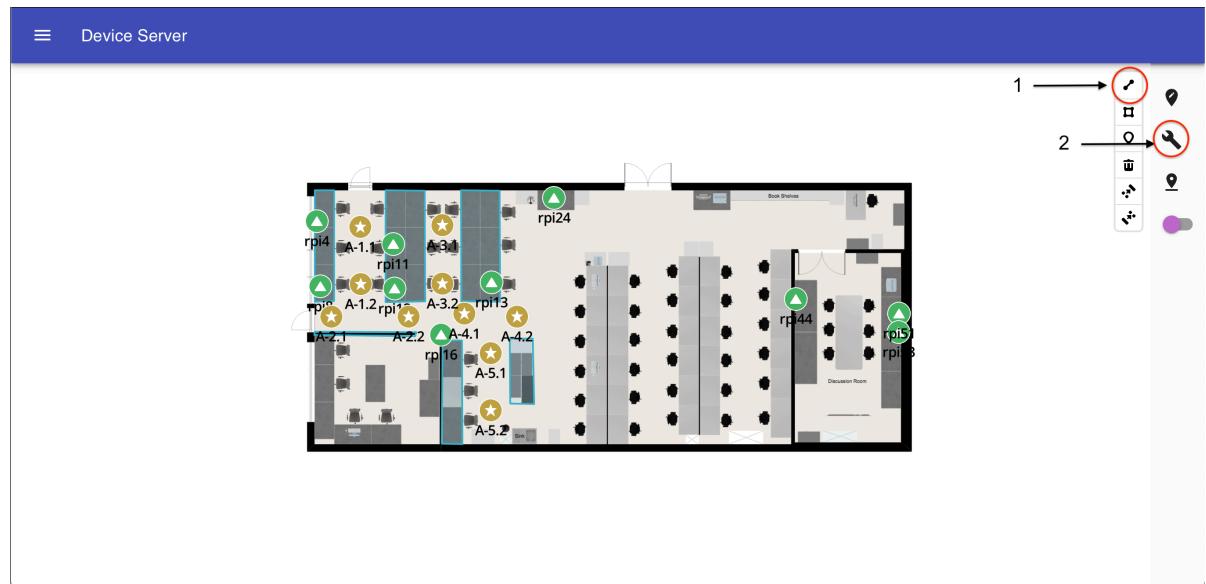
pm2 start barycentric

- Do take note that algorithm server can only be run last, meaning all the above servers need to be running properly before this can be ran
 - You can check the localisation results (Positioning or RSSI) in the kibana website

Setting Up the Experiment

Create Map - this is only required if there is a need to create a new map

- Navigate to the developer website (52.77.184.100:3001/Maps)
- Click on the top right button and click create
- Enter the map name in the id section and upload a PNG or JPG file
- For the scale section, leave it first and click create
- Once the map is created (you will know when the image you uploaded appear as a map), calculate the length or width of one side of the wall
- Use the measure feature to get the virtual length in radians and do a simple conversion to find the scale ratio of the physical:virtual length
- First click on the line option and draw a line that corresponds to the wall you are measuring
- Then click the measure tool (represented by 2)
- Take the physical distance and divide by the radians value. The SI units should be in metres.
- Once you got the scale, click on the top right button and click Edit and insert the scale value in the scale text box



Create Static Devices (Anchors/RPI) - this is only required if the anchor is not in the system yet

- Navigate to the developer website (52.77.184.100:3001/Devices)
- Click on Static Device Tab -> ADD and a dialog box will appear for you to fill in the required information

Create Static Device

<input type="text"/> id *	<input type="text"/> anchorId	<input type="text"/> sensitivity	<input type="text"/> beaconsId	<input type="text"/> measuredPower	<input type="text"/> offset
---------------------------	-------------------------------	----------------------------------	--------------------------------	------------------------------------	-----------------------------

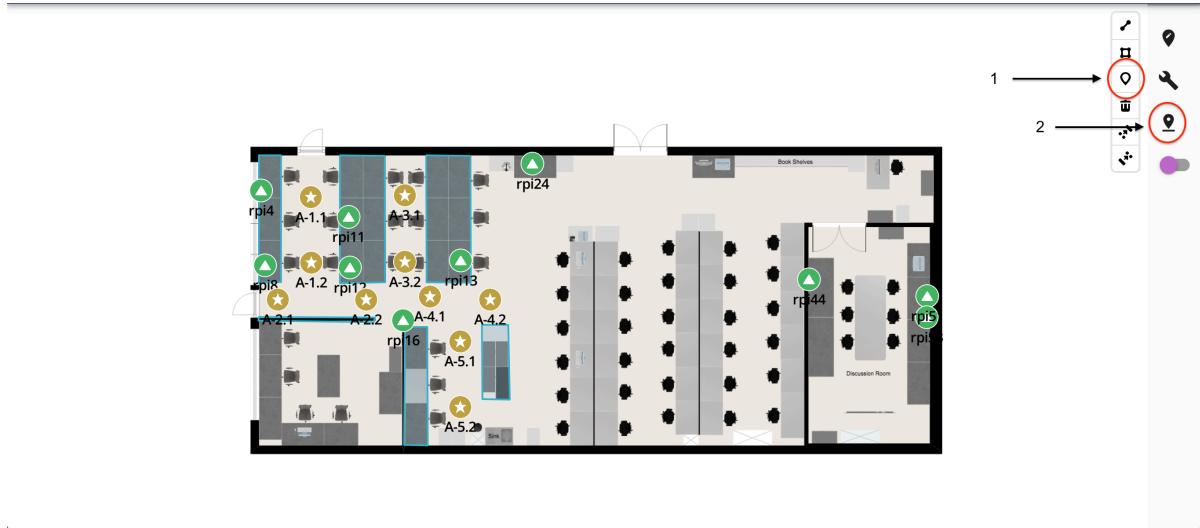
CANCEL SUBMIT

- Fill in the id and anchorId of the anchor
- id refers to the name of the anchor you would like to display on the map. AnchorId refers to the registered id, which is the mac address for the rpis
- An example of an anchor added is as follows:



Insert Static Devices into the map - this is required before running the localisation experiment

- Navigate to the Maps section (52.77.184.100:3001/Maps)
- Load Map
- Click on the marker option on the drawing tool and click on the location you want to place your anchor at in the map
- Following which click the Static Device option and select your anchor (If you can't find your anchor, it is either it have not been added to the system or it is placed in another map)
- If it is not added, add it to the devices page as seen above.
- If it is placed in another map, navigate to that map and remove the anchor



Create Mobile Devices (Beacon) - this is only required if the beacon is not in the system yet

- Navigate to the developer website (52.77.184.100:3001/Devices)
- Click on Mobile Device Tab -> ADD and a dialog box will appear for you to fill in the required information

Create Mobile Device

<input type="text"/> id *	<input type="text"/> beaconId	<input type="text"/> measuredPower	<input type="text"/> gattId	<input type="text"/> gattProfile
---------------------------	-------------------------------	------------------------------------	-----------------------------	----------------------------------

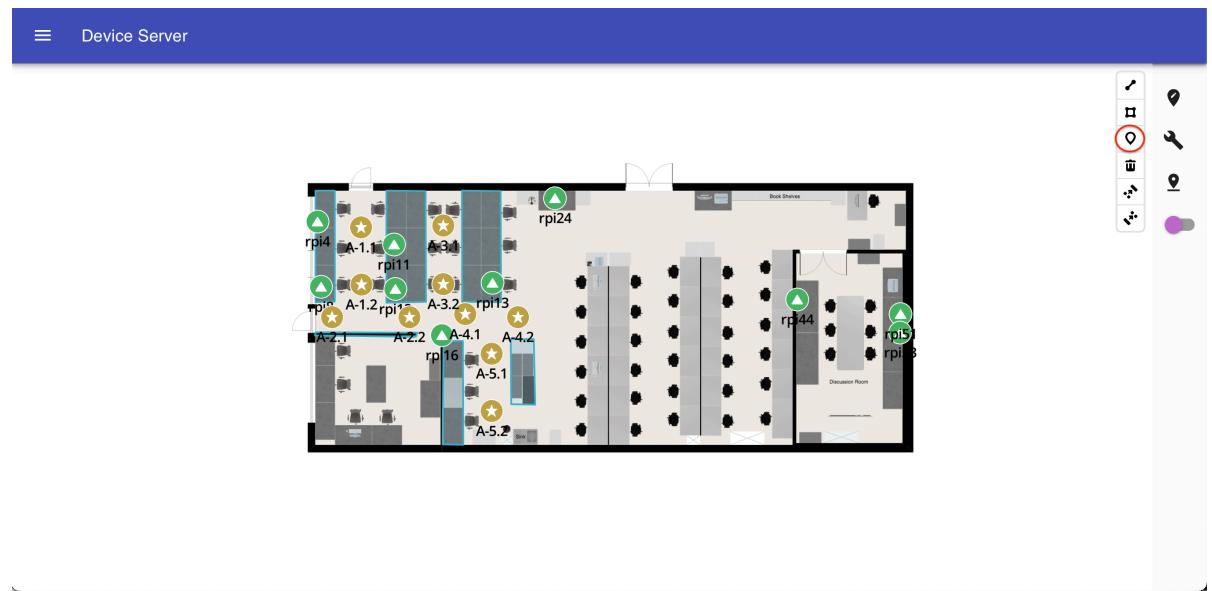
[CANCEL](#) [SUBMIT](#)

- Fill in the id and beaconid of the beacon. In some cases, you may need to fill in the measured power.
- Same as anchors, the id is the name you want to see on the map. We categorise the beacons as b1, b2 etc.
- Measured Power is fixed at -60 if not filled in
- Beacon id is the id registered in the gimbal server (for the series 10 gimbal), and is usually the major:minor like 3:1, 3:2 etc
- If it is gatt sensors you would like to add, the beacon id is the mac address of the sensor (similar to the anchor set up)
- Do note that for gatt sensors, you will need to fill in the gattid (which is same as beaconId) and the gattProfile
- An example of gatt sensor and beacon will be shown below

b7	3:7	-60	
ecg0	d03972bcbd23	-62	d03972bcbd23 {"fff0":{"fff4":{"notify":true}}, "fff3":{"write":{"data":[6],"timer":100}}}

Create Point of Interest (POI) - do this when you need some POI as some checkpoints or markers

- note that these points will not affect the experiment, they are just markers for post analysis
- Navigate to the developer website (52.77.184.100:3001) and click on the side bar to select Maps
- Load map (top-right button)
- Click the marker option on the drawing tool and place your POI point where you want on the map and give it a name



- You can then find the coordinates of the POI in the graphql
- Navigate to the graphql website (52.77.184.100:3000/graphql)

```

1 # GraphQL is an in-browser tool for writing, validating, and
2 # testing GraphQL queries.
3 # Type queries into this side of the screen, and you will see intelligent
4 # typeahead's aware of the current GraphQL type schema and live syntax and
5 # validation errors highlighted within the text.
6 #
7 # GraphQL queries typically start with a "{" character. Lines that start
8 # with a # are ignored.
9 #
10 # An example GraphQL query might look like:
11 #
12 #
13 #   {
14 #     fieldArg: "value" {
15 #       subField
16 #     }
17 #   }
18 #
19 #
20 # Keyboard shortcuts:
21 #
22 # Prettify Query: Shift-Ctrl-P (or press the prettify button above)
23 #
24 # Merge Query: Shift-Ctrl-M (or press the merge button above)
25 #
26 # Run Query: Ctrl-Enter (or press the play button above)
27 #
28 # Auto Complete: Ctrl-Space (or just start typing)
29 #
30 #
31 #query {
32 #   maps {
33 #     id
34 #     pois
35 #   }

```

RESULTS

```

{
  "data": {
    "maps": [
      {
        "id": "actlab",
        "pois": [
          {
            "type": "poi",
            "title": "A-3.1",
            "id": "A-3.1"
          },
          {
            "id": "3ea1905907b82a10575eae9d87894cc",
            "type": "Feature",
            "properties": {
              "type": "poi",
              "title": "A-3.1",
              "id": "A-3.1"
            },
            "geometry": {
              "coordinates": [
                -0.006201019807718922,
                0.16789956657062532
              ],
              "type": "Point"
            }
          },
          {
            "id": "df8ecf464313d644158c4f6c1a0f71ac",
            "type": "Feature",
            "properties": {
              "type": "poi",
              "title": "A-3.2",
              "id": "A-3.2"
            },
            "geometry": {
              "coordinates": [
                -0.006201019807718922,

```

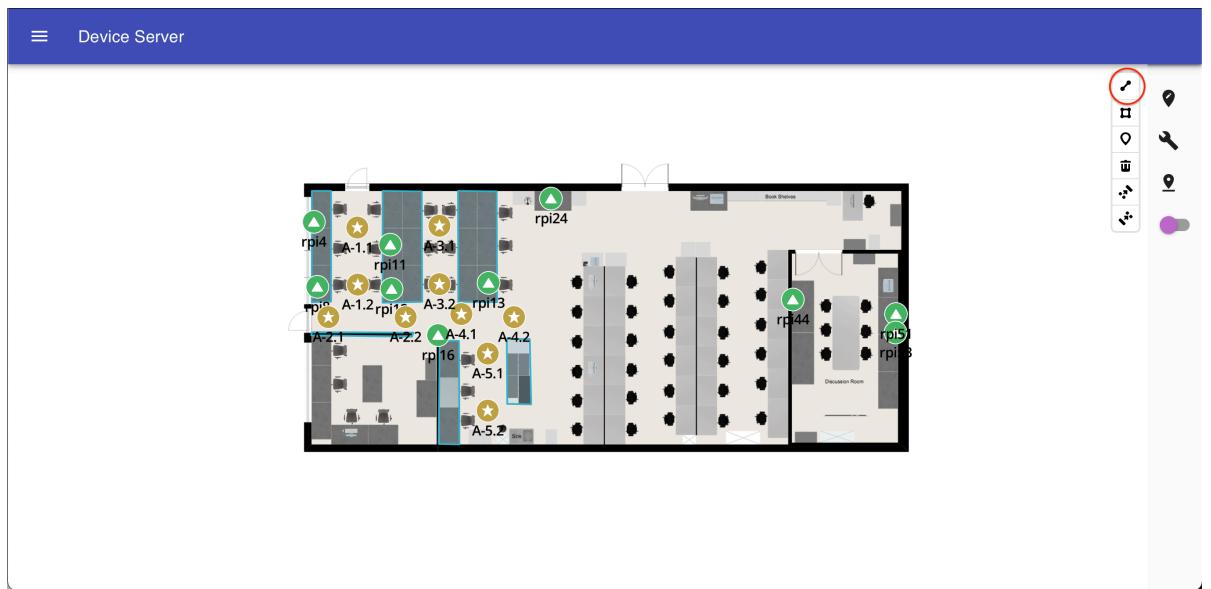
Create Navmesh - do this when you need some mesh objects as some boundary or markers

- note that these points will not affect the experiment, they are just markers for post analysis
- Navigate to the developer website (52.77.184.100:3001) and click on the side bar to select Maps
- Load map (top-right button)
- Click on the rectangle option on the drawing tool and draw the mesh object on the map



Create Navpath - do this when you need some path as some set path or direction

- note that these points will not affect the experiment, they are just markers for post analysis
- Navigate to the developer website (52.77.184.100:3001) and click on the side bar to select Maps
- Load map (top-right button)
- Click on the line option on the drawing tool and draw the path on the map



Extracting Data (Raw, Pos)

The extraction scripts are stored in the scripts folder of the indoor localisation project directory (/data/var/www/html/indoor-localisation-2.0/scripts/extract-data)

1. ExtractRawData.py
 2. ExtractPositionData.py
- Open terminal and ensure you are in the extract-data directory
 - Run the appropriate script with its required arguments

```
[ec2-user@ip-10-0-12-15 extract-data]$ python3 extractRawData.py 2022-10-12T12:00 2022-10-12T13:00 10000 test.csv
```

Script → Start Datetime → End Datetime → Query Size → CSV filename