MapCreator 2 – Mapping Guide

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Overview

IndoorAtlas technology requires the collection of indoor sensor data to create an accurate map of the environment. This guide describes the mapping workflow using the IndoorAtlas MapCreator 2 (download). First, the guide explains the steps on how to easily begin the collection of geomagnetic, WiFi and BLE data of indoor space, and the basic usage of MapCreator 2 application. Later sections elaborate e.g. on the topics of high-quality map collection and beacon installation.

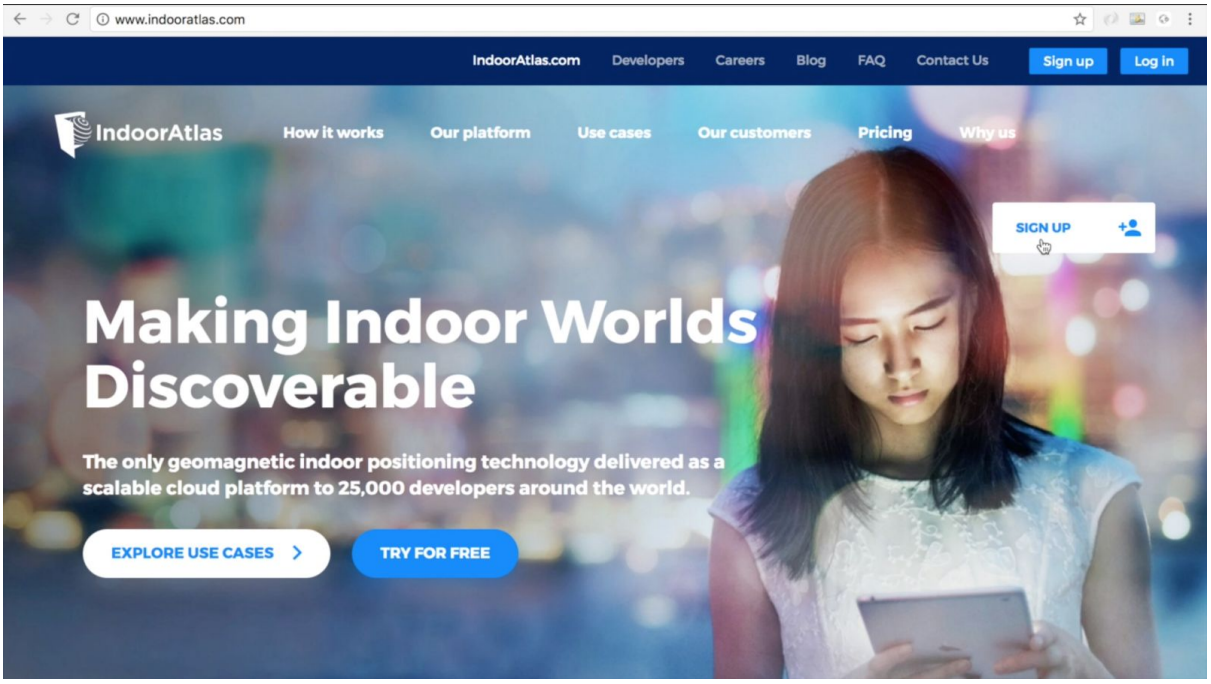
The mapping workflow described in this guide is an essential part of indoor positioning system (IPS) development using IndoorAtlas technology. Data collected at the time of the mapping is used during user positioning and required in order to accurately calculate the latitude and longitude of the user.

Before you begin the mapping work, make sure to prepare yourself by reading the description of each of the following steps.

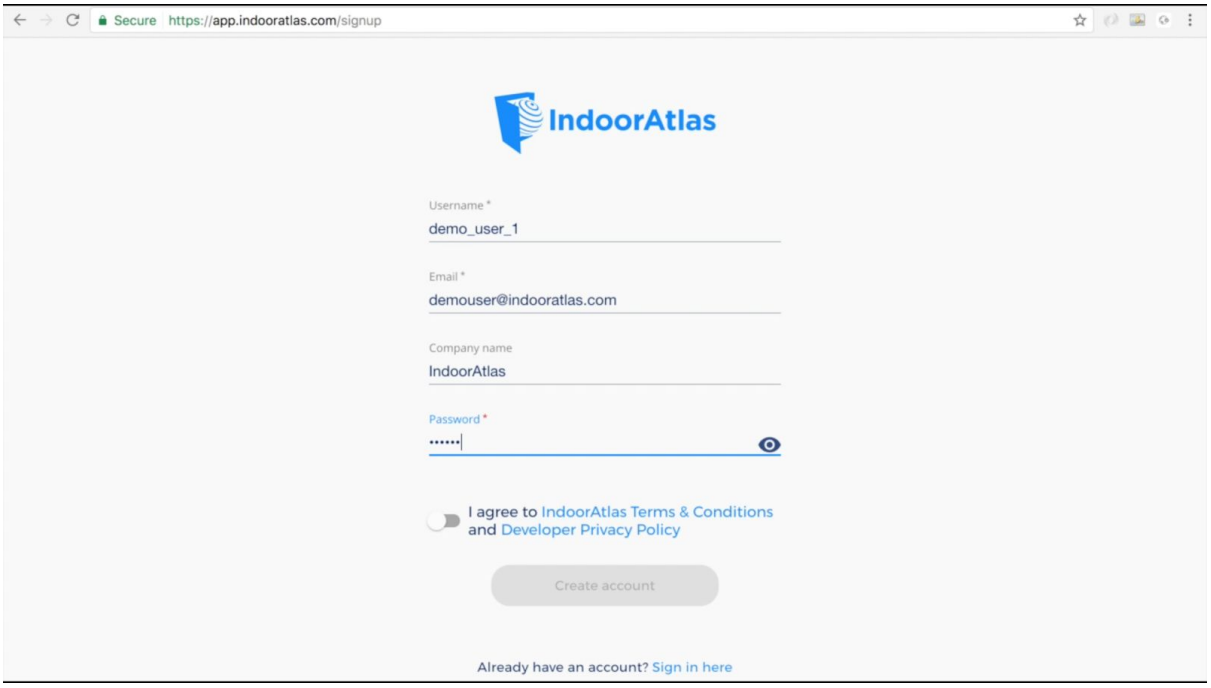
Our YouTube channel lists a set of video tutorials describing the floor plan upload and alignment, waypoint positioning, device calibration and mapping process which may be helpful to get started with mapping using MapCreator 2.

Create Your Account

First, use your browser to access IndoorAtlas homepage and to create your account. The account creation is easy and you are guided by a simple wizard that asks you the needed information.



Sign up. *Select the 'SIGN UP' button to start your signup process.*

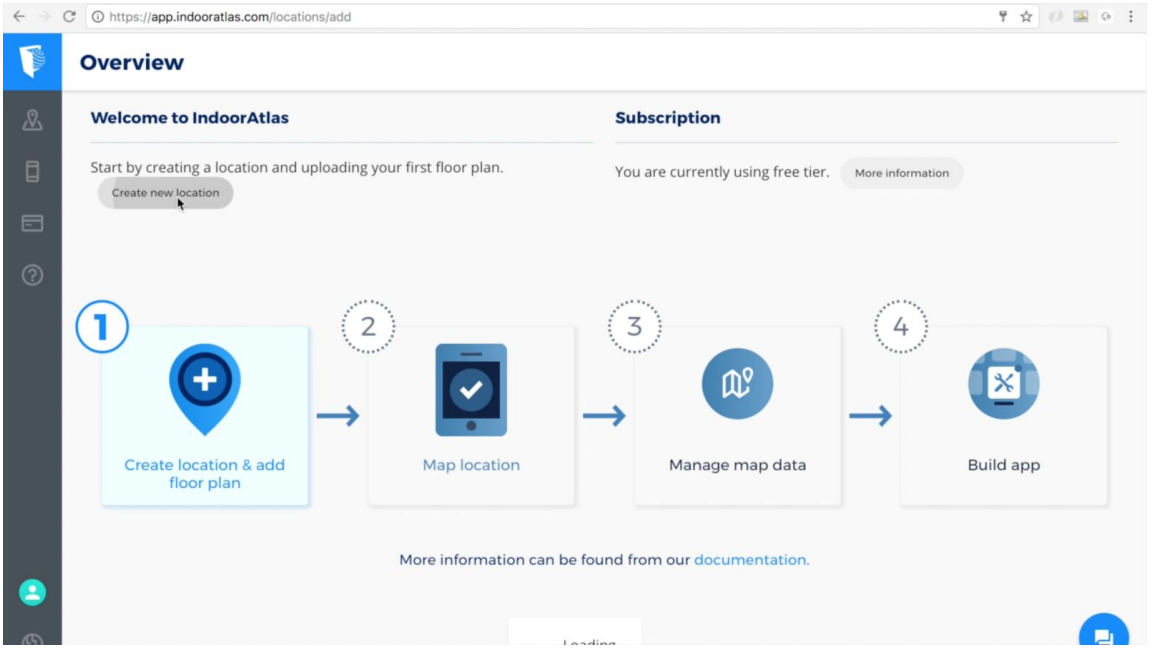


Account details. *Fill in the fields and follow the instructions presented to you by the wizard.*

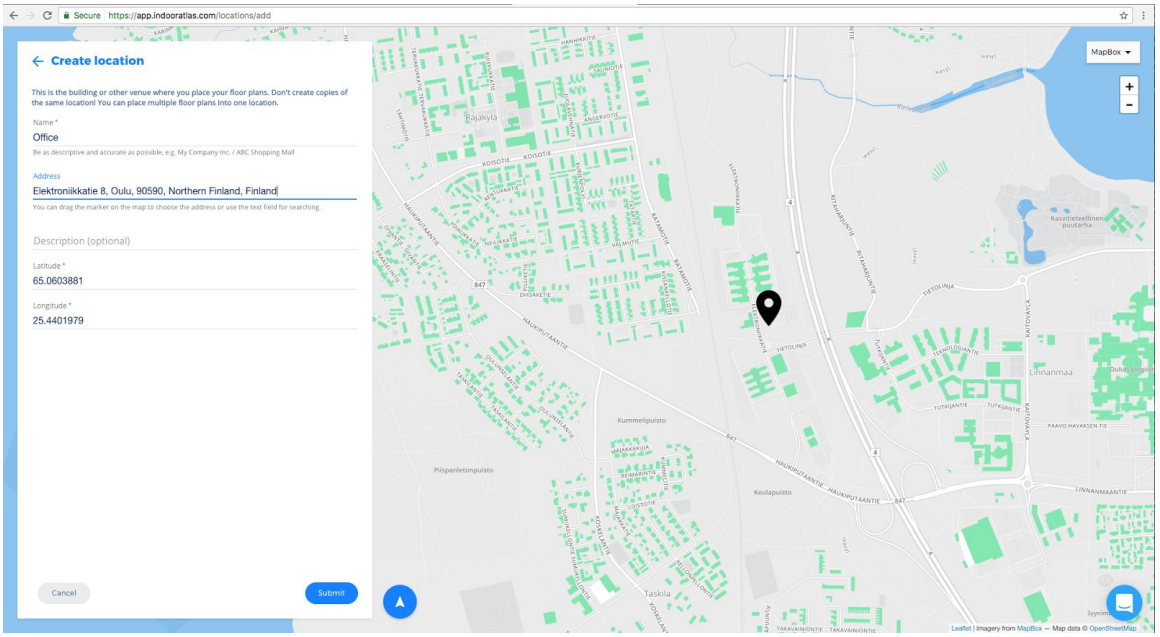
Create Your Location

Add New Location

Once you have created your account use the webtool dashboard to create your location.



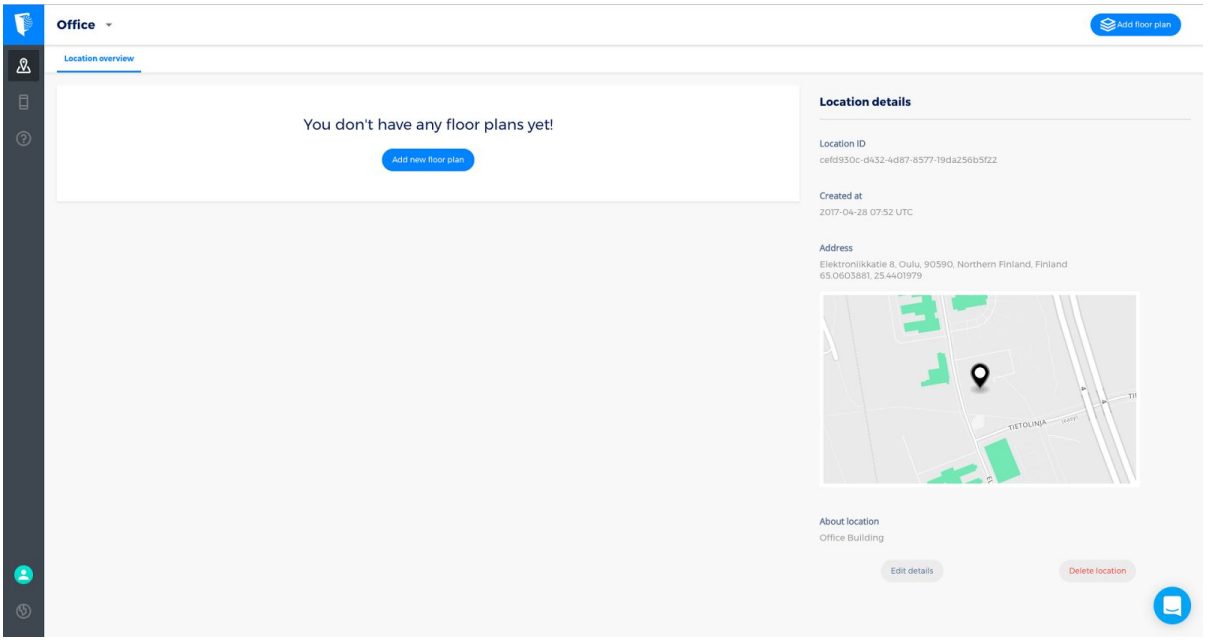
Add location. *Start the location creation from your dashboard.*



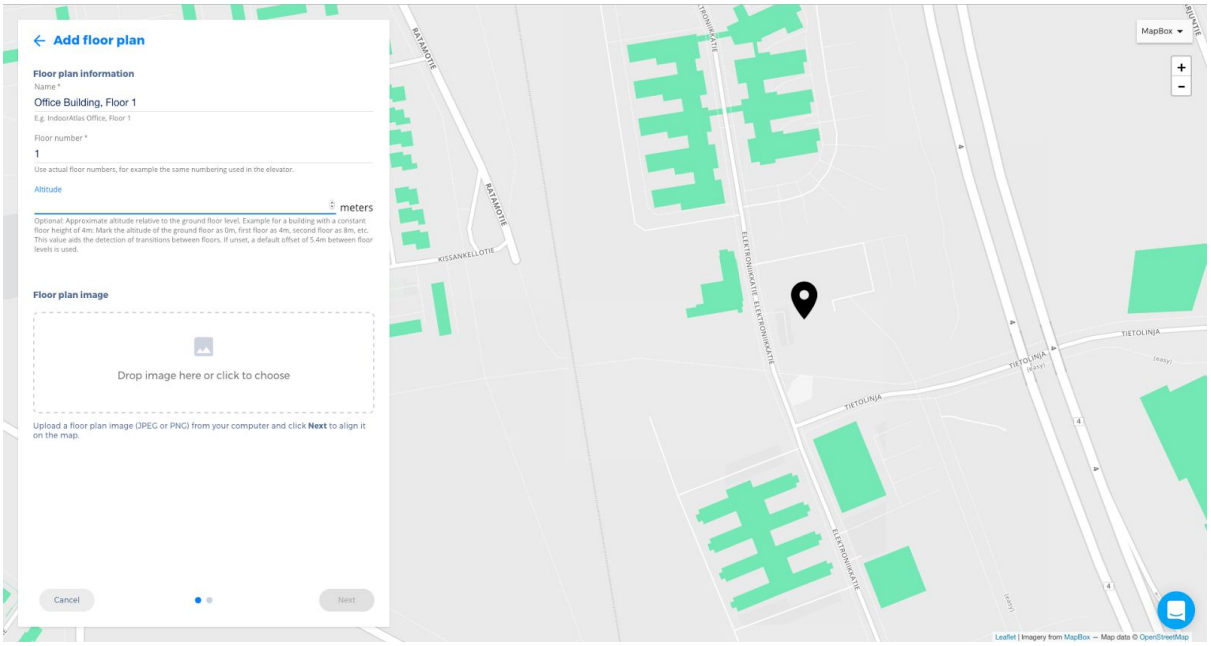
Location details. *Fill in the fields for your location with a descriptive title, an optional description and the address of your location. The map is automatically updated based on the address you type in. The pointer needs to be placed on top of your actual location on the map.*

Add New Floor Plan

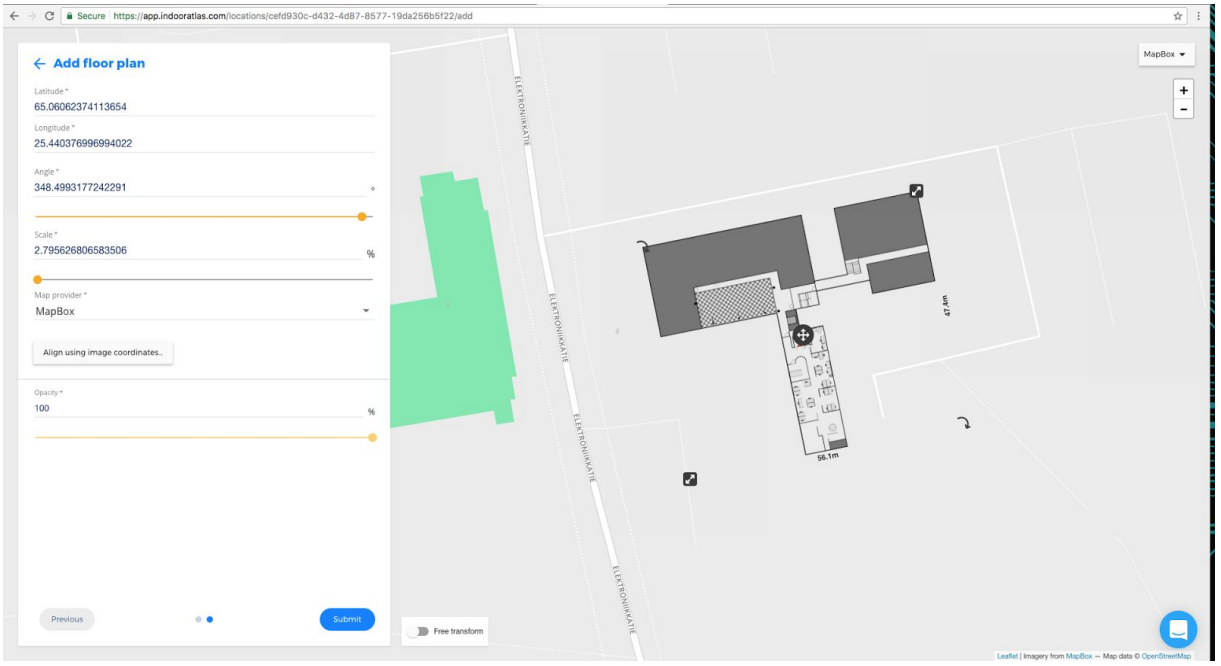
After you have created your location you will still need to add floor plan(s) under it. The floor plans are used as an aid during the mapping process and for binding the measured sensor data to the real world map. **It is essential that the floor plan used for mapping has enough reference details (e.g. pillars, walls) and it matches to the real world situation at your location.** Transforming a CAD drawing to a png gives you the most accurate and detailed floor plans. If you don't have access to such, use the most detailed floor plan image you have.



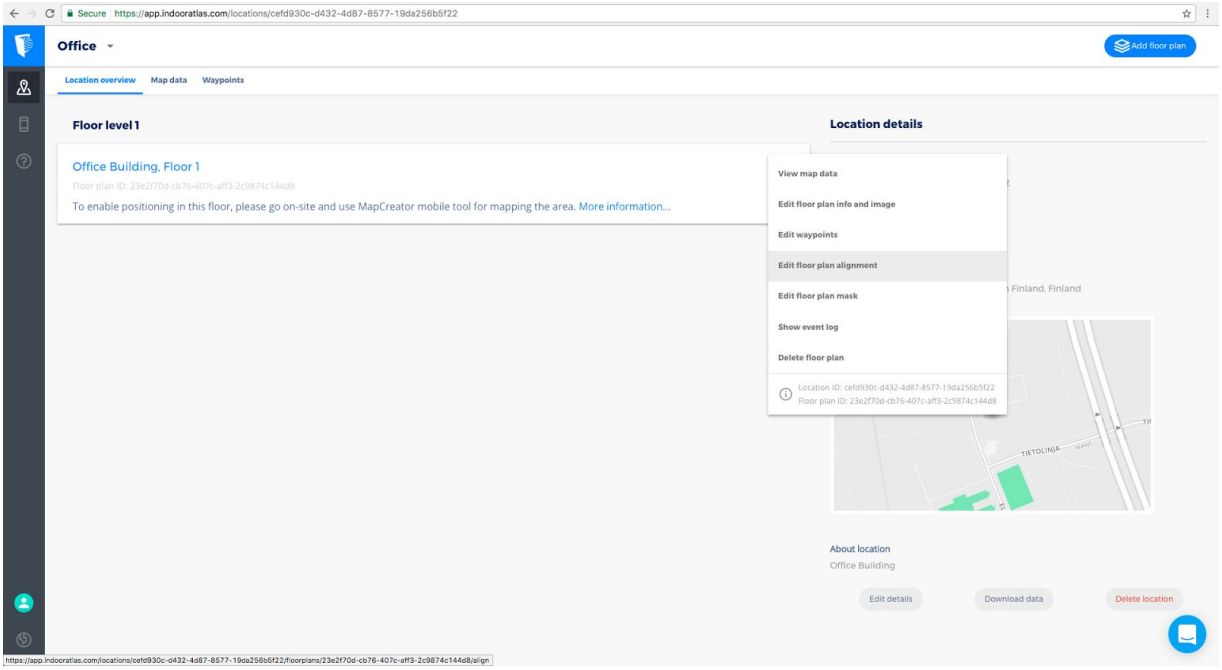
Add floor plan. *For adding a floor plan first open your newly created location and select 'Add new floor plan'.*



Floor plan details. *Fill in the the name, floor, optional height of the floor (helps with floor level detection later on) and upload the floor plan image (.jpg or .png format, minimum 5px and maximum 10px per meter).*

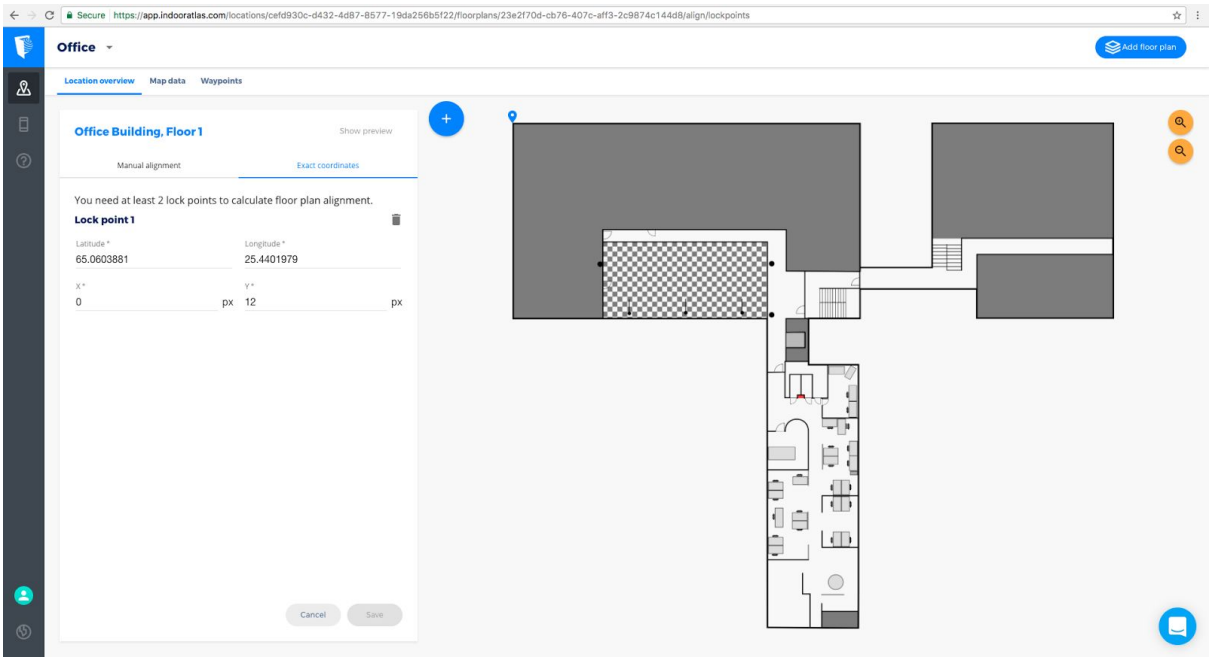


Align the floor plan. *Next the floor plan has to be aligned on the real world map. The alignment can be done manually using the resize and rotate functions on the map. Optionally you can also enter the coordinates of the corners of your floor plan using the 'Align using image coordinates' button at the bottom of the form.*



Adjust alignment. *You can later on adjust the alignment of your floor plan from the three dot menu which is located to the right of your floor plan name in the 'Location overview'. To adjust select 'Edit floor plan alignment' from the menu.*

Note: Before the floor plan can be submitted you will have to at least roughly align the floor plan onto your location. Misaligning the floor plan can cause problems that are difficult to detect later on. Make sure to align the floor plan properly before moving on to the mapping phase.



Align with exact coordinates. *You can either manually adjust the floor plan like it was done in the previous step or align using the exact coordinates option. This option allows you to explicitly bind points of your floor plan to GPS coordinates of the real world using markers. Use the marker addition button at the top left of your floor plan (circle with the plus sign) to add markers and the left side menu to enter the latitude and longitude of that point.*

Note: The measurement of the latitude and longitude at the specified points has to be done using an external tool (GPS positioner, Google Maps, etc.) of your choice. For example if your application overlays the floor plan on Google Maps then you should use Google Maps to check and align your floor plan. The exact coordinates option provides only the means to align the floor plan using GPS (WGS84) coordinates.

Map Your First Location – Beginner Guide

Mapping Setup

Device Compatibility

In order to check the compatibility of your device please read the application description in Google Play for MapCreator 2. At the time of writing this guide the recommended devices for production quality mapping are listed below:

- Nexus 5 & 5X
- Nexus 6P
- Honor 8
- LG G4 & G5
- OnePlus 2 & 3
- Oppo R9s

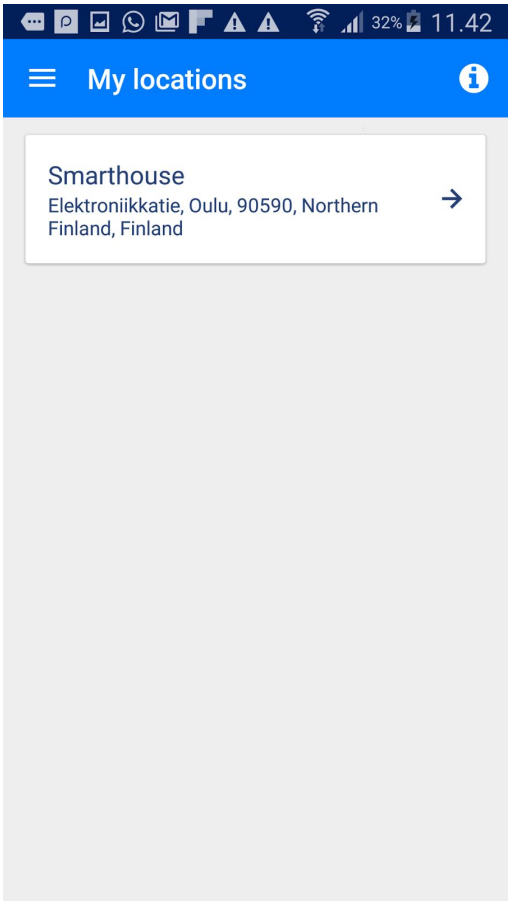
By using a device from the above list you can make sure that the sensor data is recorded properly. Other Android devices including the needed sensors (accelerometer, magnetometer, gyroscope) and OS-version 5 or newer can be used as well. Please note the device needs to have hardware sensors - e.g. a virtual gyroscope doesn't provide the needed data. Samsung devices are not recommended for *mapping* because of the sensor filtering that prevents IndoorAtlas positioning to work in an optimal way. In positioning most devices in the market are supported.

Installation

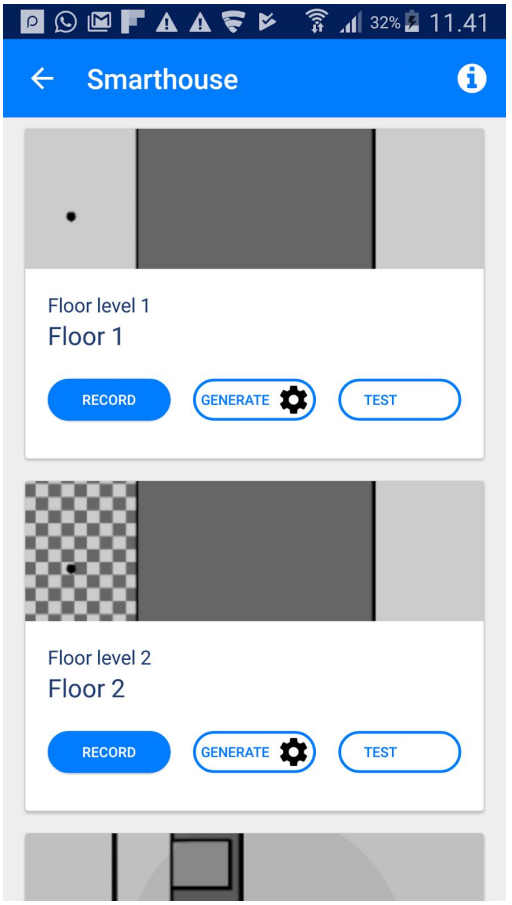
In order to install MapCreator 2 find it on Google Play and install it on your device. A straight link to MapCreator 2 can be found here.

Login Using MapCreator 2

After the installation completes please start the MapCreator 2 and enter your username and password on the login screen that follows. Next, a quick mapping tutorial will be shown. Please read the tutorial carefully. Once the tutorial finishes you will see a list of the floor plans which is also the main screen of the application.

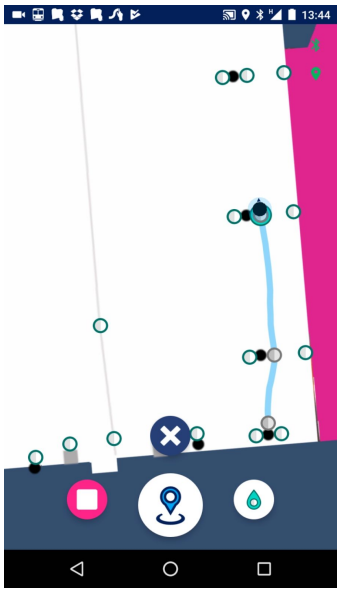


Venue List View. *This view lists the locations i.e. venues that you have added through app.indooratlas.com. Tapping a location/venue takes you to floor list view.*

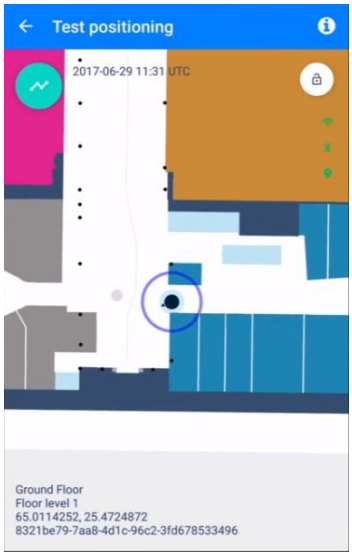


Venue's Floor List View. *After selecting a venue from your venue list, you'll see the list of floors. Here you select "record", when you are going to map i.e. collect more signal data. "Generate" triggers map generation for the floor. "Test" takes you to positioning view – remember to generate a map before this.*

Mapping and Positioning Screen Descriptions



Mapping Screen



Positioning Screen

Mapping screen items:

Show mapping tutorial.

Hide/show path history.

Add waypoint.

Start path recording.

Stop path recording.

Check-in to waypoint.

Undo check-in (10 sec timeout).

Analytics menu.

Center on current position.

Received signal indicators

Wifi icon blinks when the device receives a Wifi scan.

BLE icon blinks when beacons are being recorded.

Platform location icon blinks when the device receives a platform location.

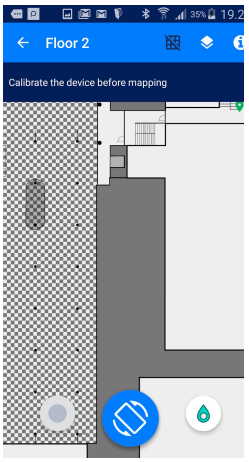
Positioning screen items:

Lock icon. When locked: positioning is forced to the selected floor image. Non-locked: IndoorAtlas detects the floor automatically.

Mapping Preparations

Adding Waypoints

Before starting the mapping you should plan the route you will walk to collect the data. The waypoints act as confirmation points for your data collection paths. For more details about waypoint placement, see Collecting high quality maps with MC2 section below.

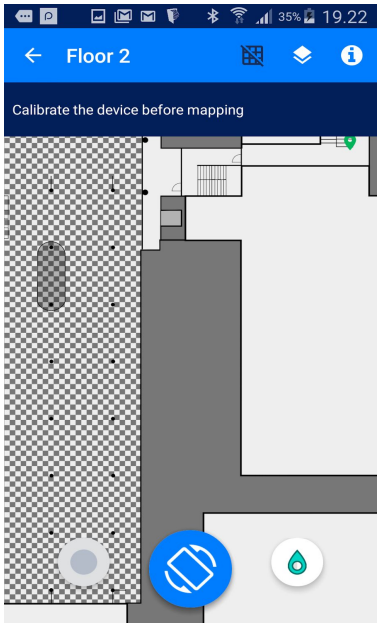


1. The waypoint adding icon is displayed at the bottom right of the mapping screen. Tap this icon and after it has been selected tap the place on the floor plan where you would like to place the waypoint.
2. You can change the position of the already existing waypoints by long pressing the waypoint. This will turn the waypoint into a position marker that can be used to change the location of the waypoint.
3. When placing your waypoints take advantage of the distinct features of your floor plan such as pillars, doors and stairs to ease the mapping effort.
4. To delete a waypoint select “Remove” from the bottom menu when the waypoint is in the edit mode.
5. In order to avoid the situation where the position wanders over the walls make sure to leave approximately 1 meter space between the wall and the waypoint.

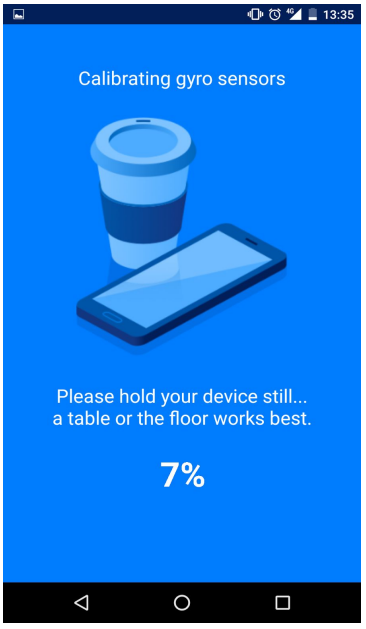
Mapping Workflow

Calibration

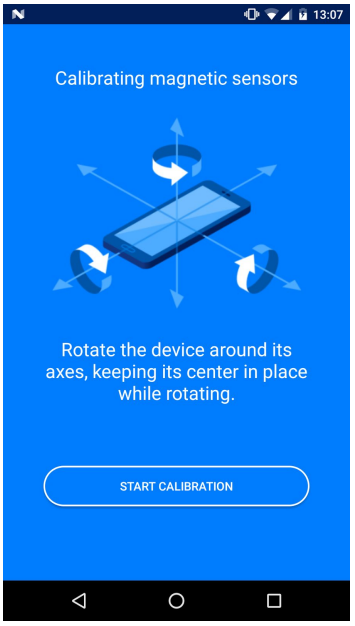
Often, the gyroscope and magnetometer sensors of the device are biased. In order to deal with these offsets in the measurement device you must first calibrate the sensors.



Step 1. *To start the calibration, tap the blue button in the bottom of the screen.*



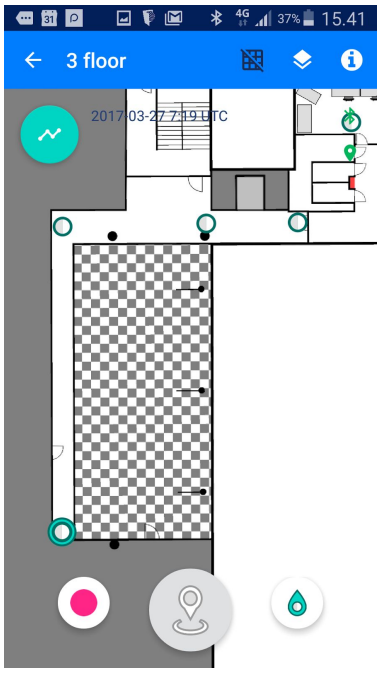
Step 2. *Before starting the gyro calibration place the device on a flat stable surface such as a table and tap on the start button.*



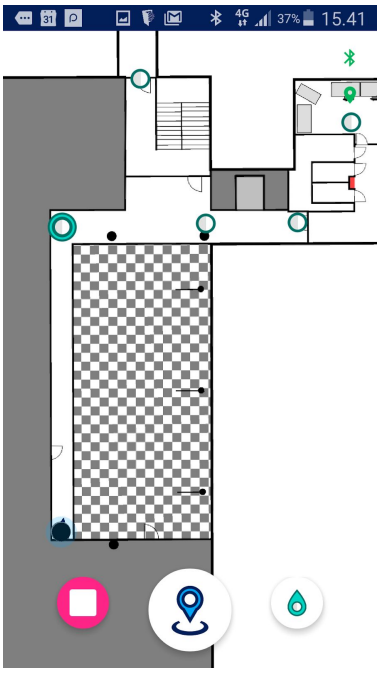
Step 3. *Once the gyro calibration finishes you will presented with the screen for magnetometer calibration. Tap the start button and rotate the device around its axis keeping the center of the device in place during the calibration.*

Mapping with MapCreator 2

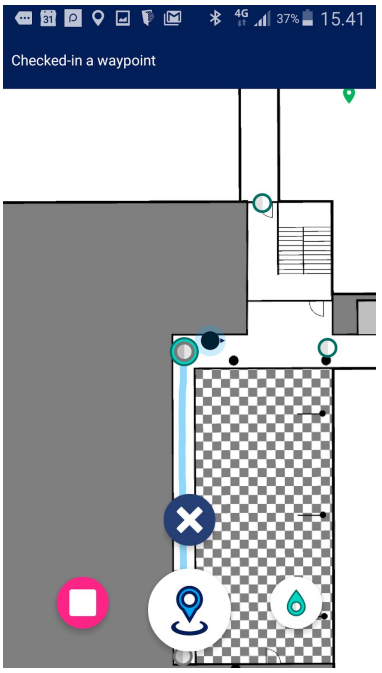
Note: If the MapCreator 2 tool is put in the background by other apps during the recording the data collection will be interrupted and you will have to start from the beginning. We recommend using the *do-not-disturb mode* on the device while mapping.



Step 1. *Select one of the waypoints as a starting point for your recording and walk on the center of the waypoint in the physical space. Plan the path (through several waypoints) you are going to walk.*

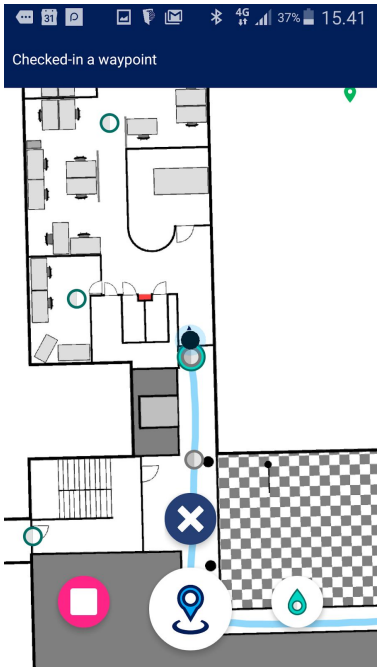


Step 2. *Tap the record button to start the data collection. Once the recording starts, begin walking towards the second waypoint and tap it.*

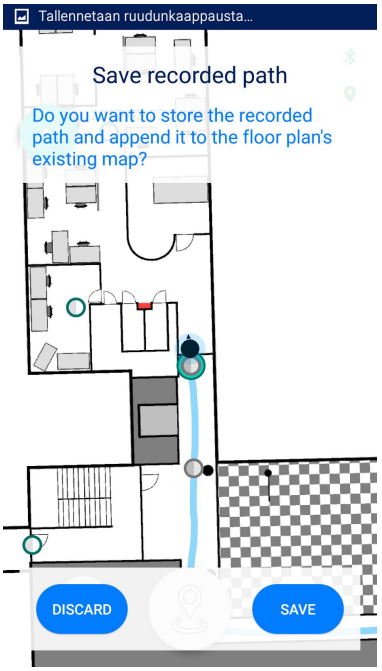


Step 3. *When you reach the second waypoint, check in using the icon at the bottom center of the screen. An estimation of the walked path is shown. Make sure this looks correct.* ***If not:*** *stop and discard the recording.*

Note: When you start walking away from the starting waypoint the dot will *not* follow you. After checking in to the second waypoint, the estimated path is shown and the blue dot starts showing your estimated current location. Note that at check-ins the estimated location gets corrected. The estimated location is only used to automatically select the waypoints along your route, so you don't often need to tap the waypoints before checking in.



Step 4. *Continue through your planned path. Check in accurately to each waypoint on your route – make sure you are right at the x,y of the waypoint when tapping the button. Note that MapCreator predicts your route and automatically selects the waypoint. If the selection is wrong, tap the correct waypoint before reaching it and then tap the check-in button.*



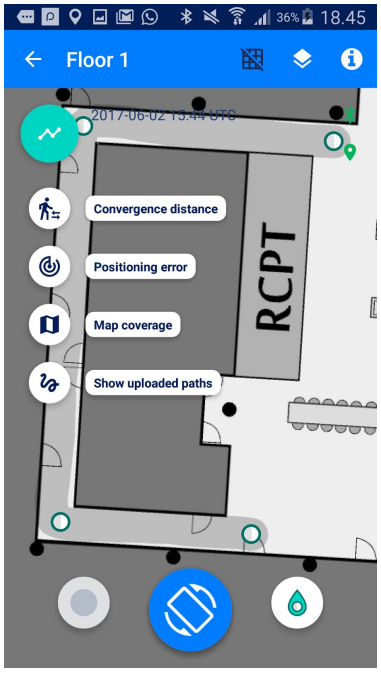
Step 5. *Once you have reached the end of your path tap on the stop icon at the bottom left of the mapping screen to stop. The next dialog will ask you to save or discard the recording. If there were no problems during the recording tap on the save button. Otherwise discard the results and repeat the recording.*

Step 6. Continue repeating the mapping steps until you have covered all of the walkable area on your floor plan.

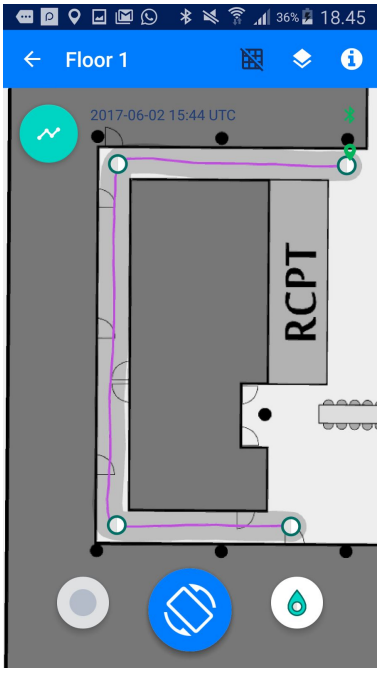
Note: When the waypoints are set and used *accurately* the blue dot should visualise your walking pattern well or with only little drift. If the blue dot keeps drifting badly or the tracking performance decreases suddenly during mapping check that the waypoint placement and the floor plan image alignment matches the actual check-in points and the real floor plan.

Map Generation

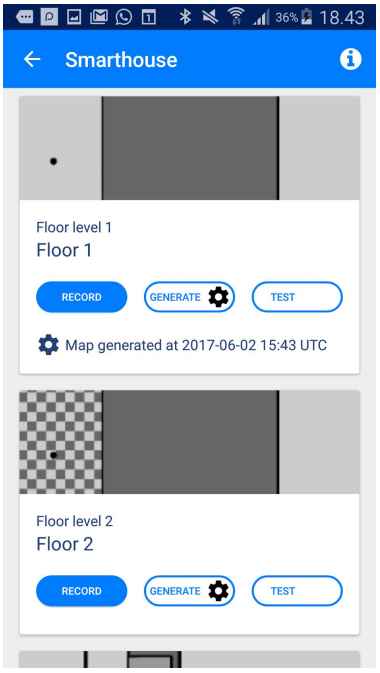
In order to test positioning, the recorded paths must be uploaded and the map must be generated. You can see the pending path uploads and generate the map in the *floor level list view*.



After one or more paths get uploaded to the service you will be able to view against your floor plan. To do this tap on the "Show uploaded paths" icon under the analytics menu.



The uploaded paths are shown in purple. If you can't see all of your paths on the floor plan you can go back to the floor level list (see next step) and it will show how many pending path uploads there are.



Once all of the paths have finished uploading and you are happy with the coverage of the path you can go back to the floor plan list and tap "Generate" to start the map generation.

MapCreator Warnings

MapCreator does automatic sanity checks for the collected data. If you see any warnings pop-up during mapping you can stop the recording and save the progress until the last check-in. The path after the last check-in is automatically discarded.

Wifi scanning rate

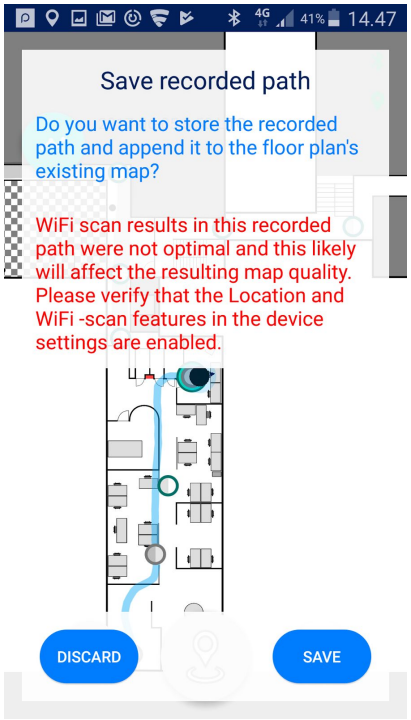
Some sanity checks are performed just after the recording is finished. Here's an example about Wifi scanning rate – if you see this warning, you should discard the recording and verify :

- You are using one of the supported *mapping* devices
- Location feature is enabled
- Wifi-scanning feature in the settings is enabled
- You did not disable Wifi during recording the path

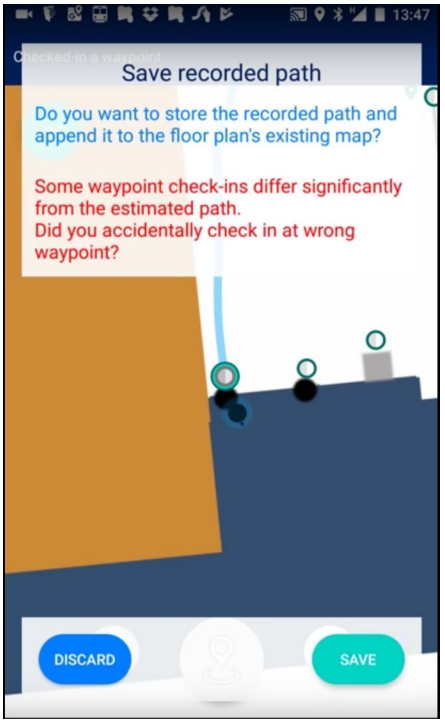
Incorrect Check-ins

MapCreator shows the warning below when it detects that during recording you have possibly checked-in to incorrect waypoints. If this happens:

- Make sure the correct waypoint was highlighted when you checked-in
- Make sure waypoints are accurately placed



Wifi scan rate warning.



Possible wrong check-in warning.

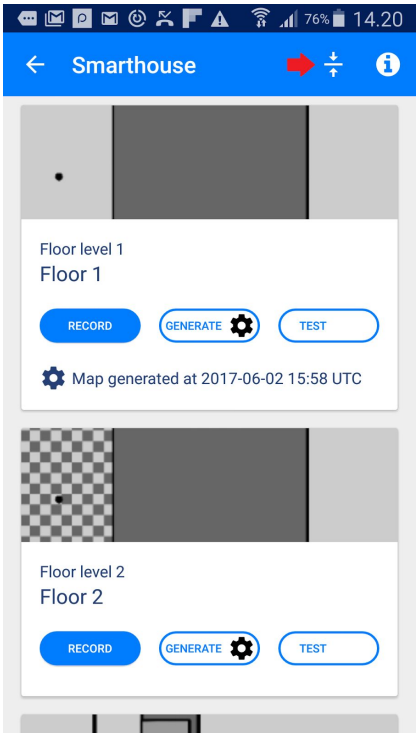
Tips on How to Walk During Mapping

- When mapping, try to walk as naturally as possible in order to keep your walking constant. Keep your phone pointed towards the direction of movement with the screen upwards.
- Walk while keeping your phone steady at the level of your belly button. Try to avoid any excessive movements and don't shake the phone.
- When you make a turn during mapping make sure that the phone turns with you.
- If something or somebody comes in the way of your path temporarily stop and wait for the path clear and continue walking again. Do not stop the measurement or do any side stepping which is difficult for the path estimator to follow.
- You can check into a waypoint several times during the same recording.
- Try to keep the length of the recordings to maximum of 5 minutes but to a minimum of 1 minute. Shorter paths are easier to repeat in case of any mistakes on the way. Make your mapping an iterative effort instead of one long path trying to cover all of the area.

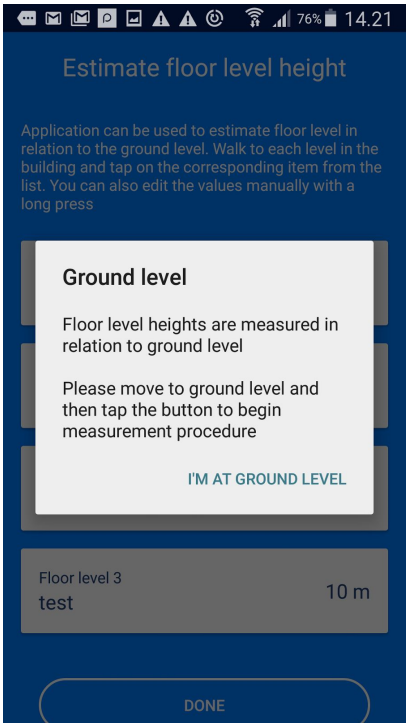
Floor Height Measurement Tool

MapCreator contains a barometer based floor height measurement tool. Using this tool you can measure the floor heights and store them automatically to the floorplan's metadata in the IndoorAtlas cloud. Note that if you don't measure the floors, IndoorAtlas will use the default floor heights in positioning.

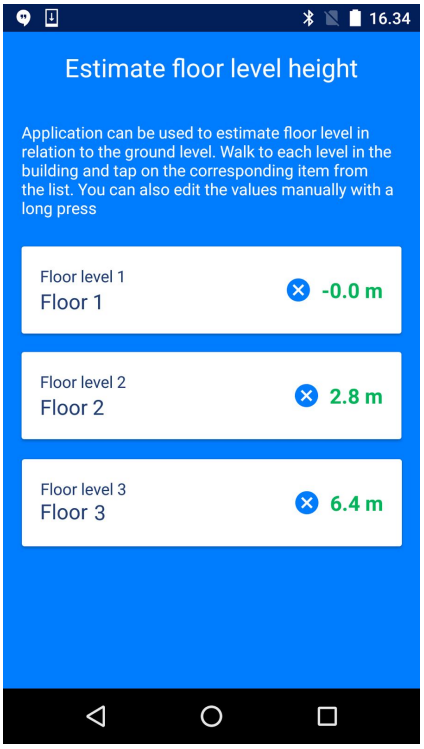
Start the floor height measurement tool by tapping the elevation symbol at a top-right, indicated by the red arrow below.



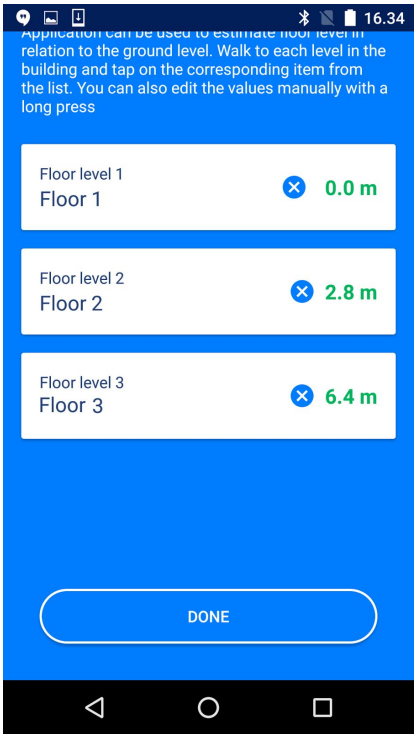
The floor height measurement tool is opened. Walk to the ground level.



When at ground level, tap "I'm at ground level". View with all floors of the venue opens. Wait until "Calibrating..." disappears.



Walk to floor 1 and tap the floor on the screen. Proceed to floor 2 etc., following the same procedure until you have measured all floors.



Then inspect the elevations and store them by tapping "Done". Note that this automatically triggers map generation to all changed floors.

Checking Map Analytics

When you have generated a map, you should go to app.indooratlas.com and check the analytics under *Draft Map*.

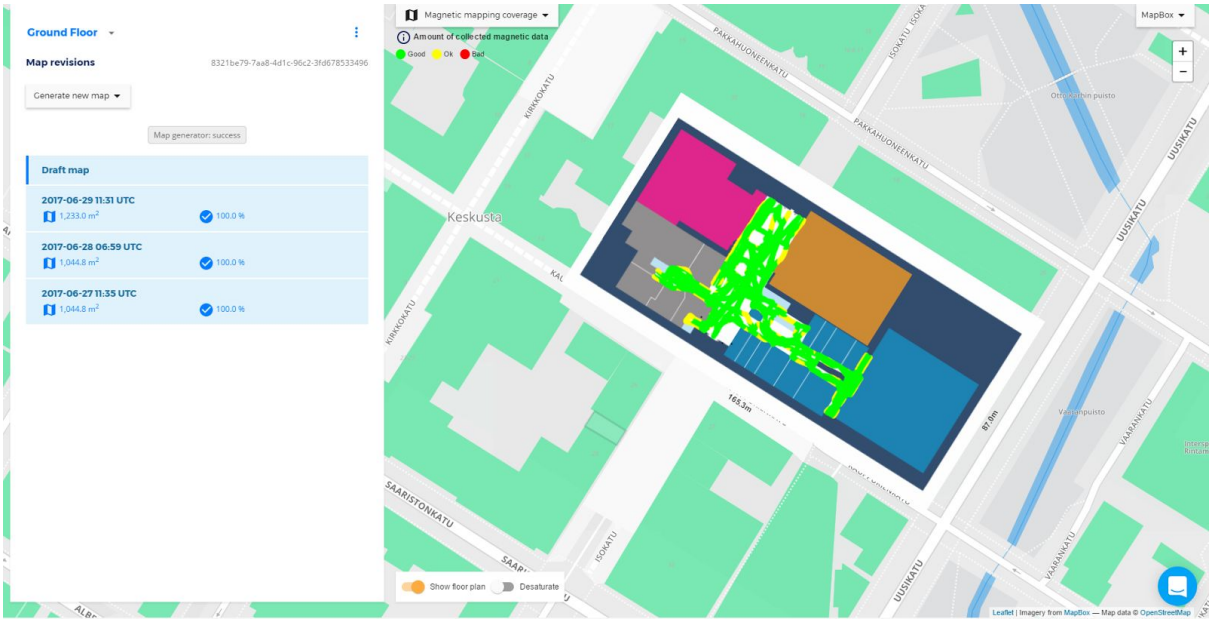
Analytics Results

Ideally you should create maps where all of the analytics are showing green. If you are getting larger areas of yellow or red please check the settings on your mapping device and that the device is working correctly. Pay attention to the way you walk and that you are not doing any excessive movements during the map path recording.

If you can think of something that could have prevented optimal data collection please replace or add new paths to the problem areas. You can disable the bad paths from the map generation at app.indooratlas.com. If the problems persists please contact IndoorAtlas support channel for additional help with your mapping.

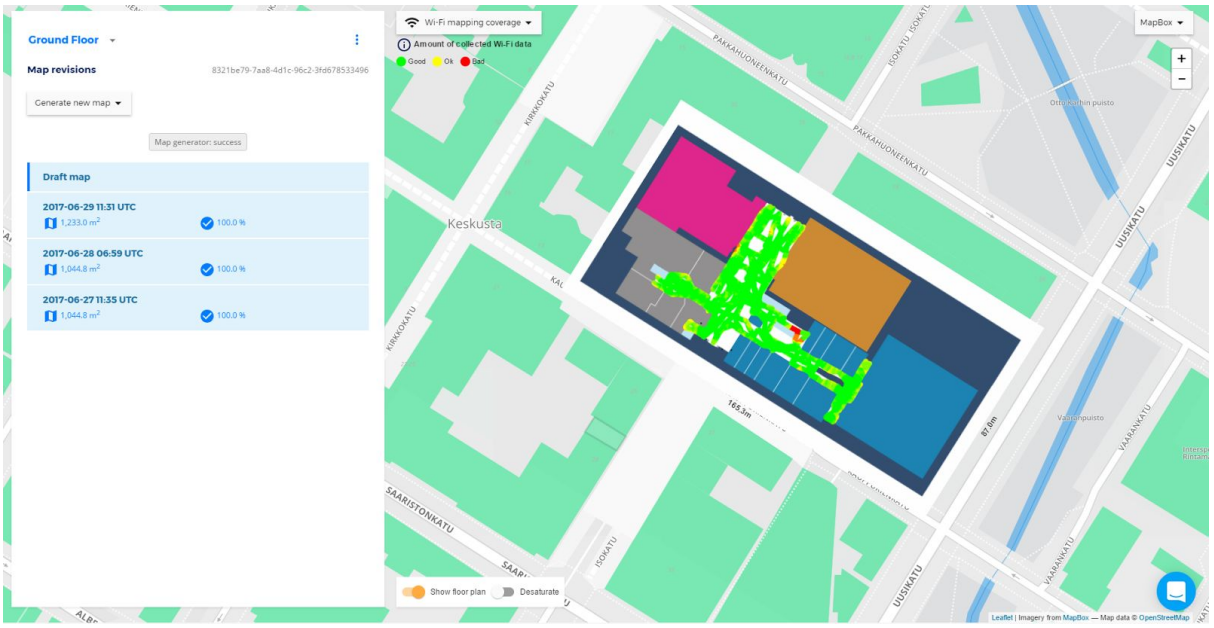
Magnetic Mapping Coverage

If there's yellow or red in magnetic mapping coverage image, this indicates that you should have another parallel path on the mapped area to have enough magnetic map samples. Usually a 1.0-1.5 meters between parallel paths on the same area is a good choice.



Wifi Mapping Coverage

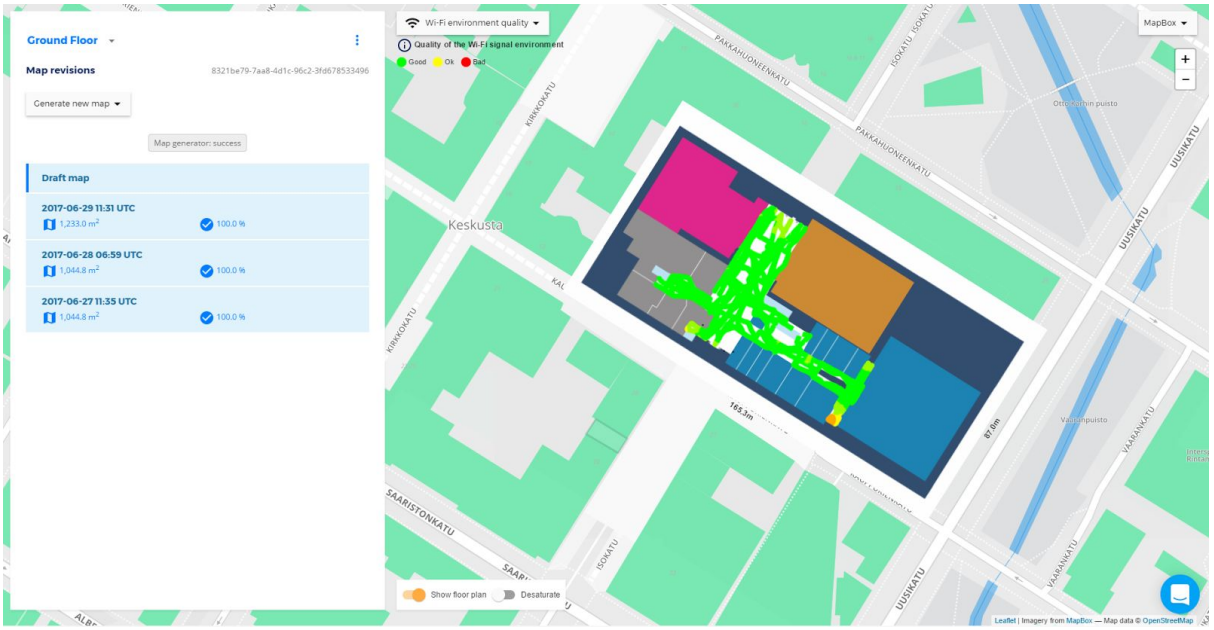
Wifi mapping coverage shows you where there's enough samples of the Wifi data. If there are some spotty areas in the analytics, add parallel paths to areas which are not green.



Wifi Environment Quality

Wifi environment quality tells you how good is the wifi radio environment for positioning. IndoorAtlas uses Wifi to achieve faster first fix than is possible with magnetic information alone.

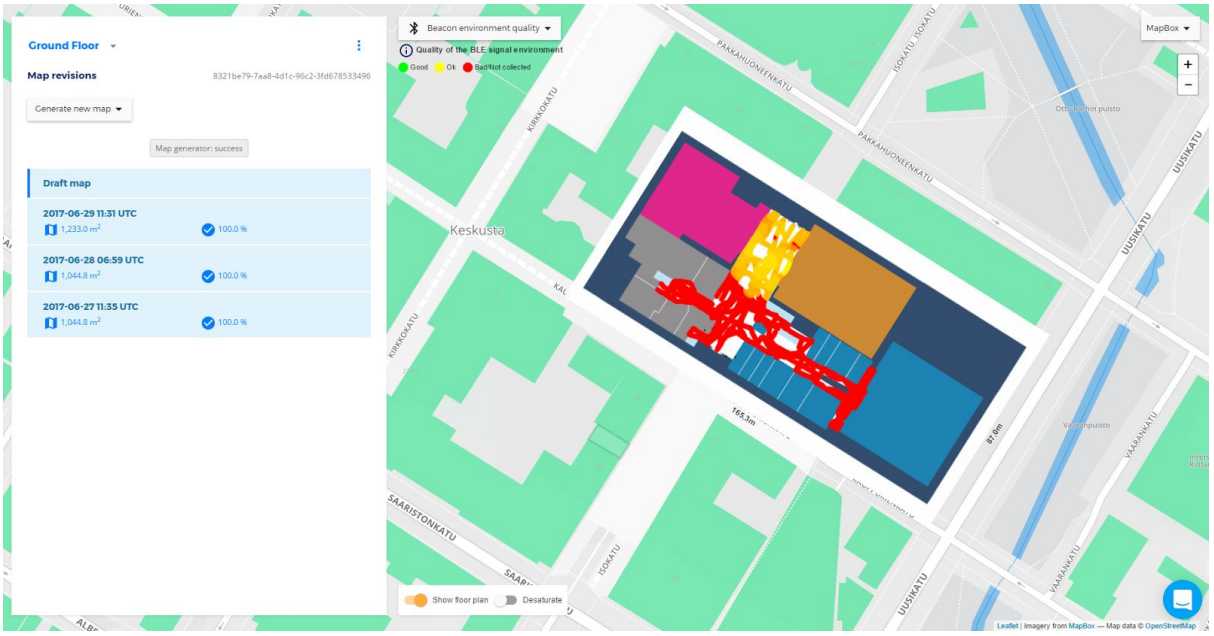
Note that in wifi environment quality image there may be areas with no color. This indicates there was no Wifi samples from that area during mapping, so environment quality cannot yet be analysed. You should add more mapping paths to such area. Green indicates excellent radio environment, yellow indicates standard, while red means that possibly fast first fix in those areas is not possible based on wifi information.



Beacon Environment Quality

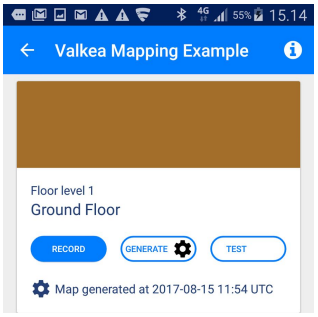
Beacon environment quality tells about how good the beacon radio environment is for positioning. Note that MapCreator automatically records ambient beacons installed by a third party. If you are installing beacons yourself, use this analytics to identify places where you should add beacons -- the red and yellow areas. After adding new beacons, add new mapping paths around the beacons to the them recorded. Then re-check analytics.

Yellow areas in this image indicate that an approximate first fix can be determined in those areas. Red indicates no beacon coverage and green indicates good coverage.



Testing Positioning

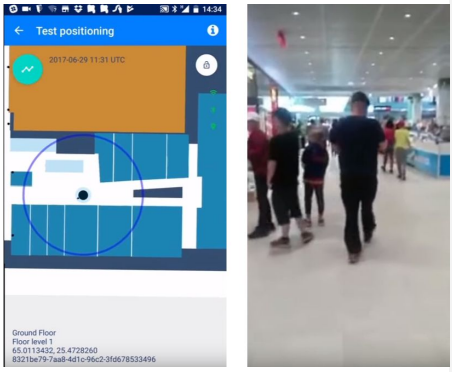
After you have successfully generated a map, you can test positioning. To start testing, select TEST from the floorplan view. Walk around and compare your current physical position to the estimate shown on the screen. You can test positioning on all floors or with one floor locked (lock symbol in the Test positioning view).



In floorplan view, select TEST to start testing.

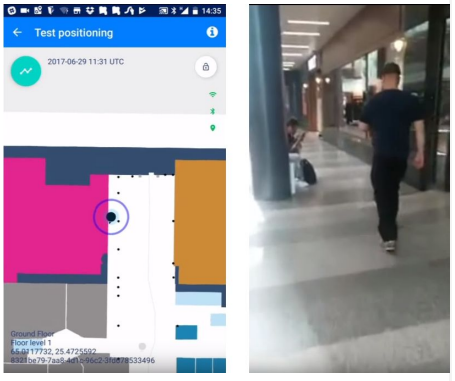
Expected behavior

The first estimate should be approximately in your location with quite large uncertainty radius. This depends strongly on the mapping quality and the radio environment (Wifi and BLE) at the mapping site. Try different starting positions to get a good picture where the first estimate is working well and where e.g. more mapping or additional beacon installation is required. Use analytics to help you.



The first estimate.

After walking for a while (10-30 m), the uncertainty radius should get considerably smaller and the estimate track your position accurately. If tracking does not seem to work optimally in some areas, check analytics if the coverage or map quality could be improved. See Advanced mapping guide for details.



Tracking after walking around.

Capturing and Reporting Trace-ID

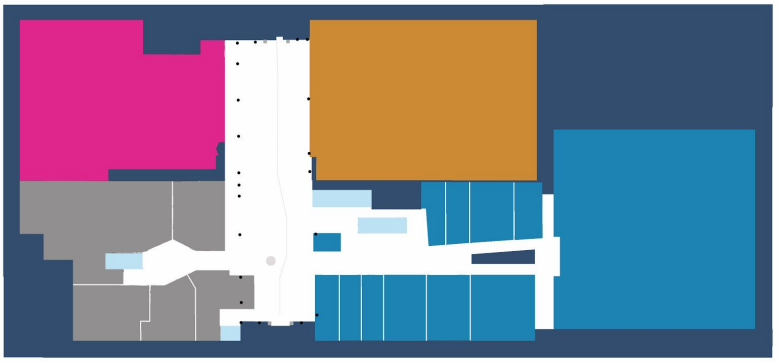
Should you encounter inaccurate positioning during your tests, please review your mapping quality – were there any warnings during mapping? Did analytics show all green? If the mapping is as good as possible, please record the trace-ID of the problematic session by *long-touching* the text field at the bottom of the "Test positioning" view (see image above). Please report this to support@indooratlas.com along with a drawing of the actual route you took during the positioning test.

Collecting high-quality maps with MapCreator 2 – Advanced Guide

Overview

This chapter describes the map collection in more detail and discusses several aspects that need to be taken into account to produce high-quality maps with IndoorAtlas MapCreator 2 (MC2) application. The effort made during the map collection is directly reflected in the final positioning performance. This chapter does not describe the general usage of MC2 or IndoorAtlas workflow, as those are described in the previous sections.

The material presented here is from a demo mapping of the ground floor of Valkea shopping mall (floor plan below is 165x87 m^2). The collected map presented here has a very good positioning performance.



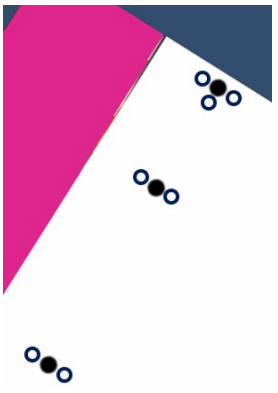
Waypoint placement

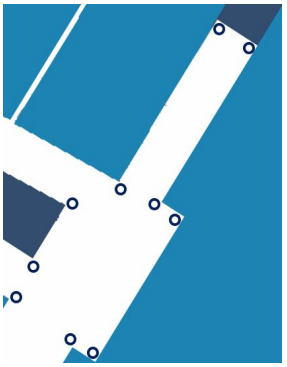
The waypoints are a crucial part of successful mapping. They tie the physical location of the mapper to the floor plan features and landmarks. The waypoint placement should reflect reality as accurately as possible, and for this an accurate floor plan is needed. The floor plan should have enough spatially correct and easily recognizable details and landmarks, such as pillars and corners, that you can align yourself with. Accurate waypoints lead to better paths, better speed estimates, better map, and in the end better localization performance. The easiest way is to add majority of the waypoints before mapping using the web tool. When arriving on the mapping site, you can then add, remove, and move waypoints with MC2 to match reality more accurately.

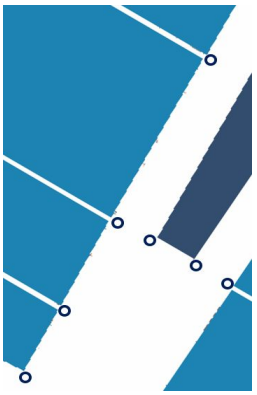
Obvious locations

Some landmarks are natural and excellent places for waypoints. You can easily detect them from the floor plan and align yourself with respect to them. These include:

- Pillars
- Corners
- Entrances, doorways, door frames
- Stairs, escalators
- Elevators
- Identifiable floor tilings
- Permanent benches
- Dividing walls between stores (e.g. in malls)



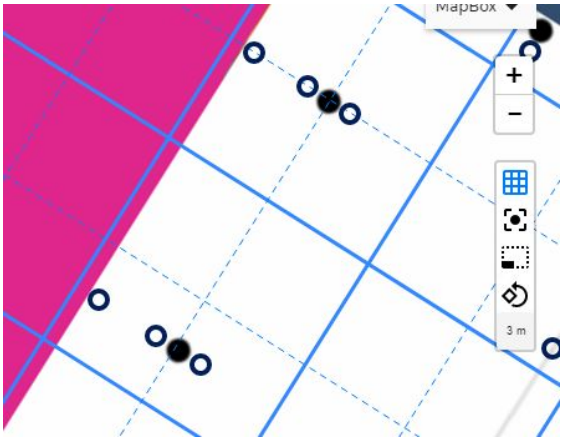




Derived and other non-obvious locations

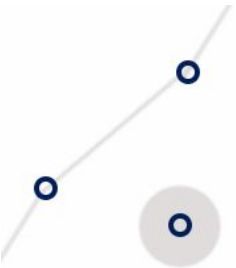
Often easily-identifiable places can be derived from the existing easier waypoint locations:

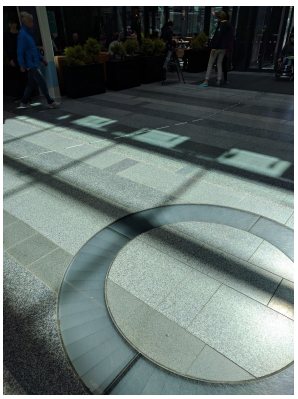
- Opposite wall of a corner or pillar
  - When walking by, it is easy to verify that you are passing the landmark on the other side of the corridor
  - Use floor tilings if available: allows using even far-away landmarks
  - Especially in corridors, also the middle point of two waypoints can be used
  - Use the grid and measurement tools to align the waypoints if needed



When at the mapping site, look around for surprising details that may be visible in the floor plan:

- Electric cable locations, fire extinguishers, etc.
- Floor and ceiling details (look up and down!)





Other considerations

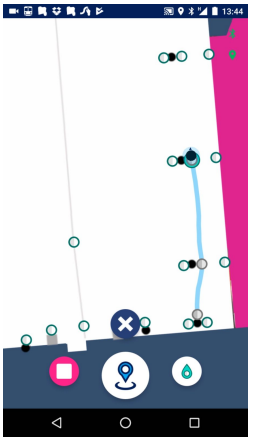
- Good waypoint distance from walls or pillars is about 0.5-1.0 m
  - Easy to walk by and check-in consistently in the same location
  - You can place the waypoints often directly on the landmark, if the landmark is e.g. on the floor
- Good waypoint distance from other waypoints is 5-20 m
  - Too close waypoints do not add much value and make automatic waypoint selection harder
  - Too far waypoints add error (drift) to the path estimation
- Be systematic
  - Use all corners, pillars, and other easily identifiable landmarks
  - Consider e.g. the most probable walking direction when placing the waypoints

Planning the collection

For efficient and error-free mapping it is often preferable to plan the collection beforehand. Although mapping in crowded places is also possible, it is much easier, when you can walk straight and continuously on unobstructed paths. Similarly, when planning your route through waypoints, you should try to keep the paths as simple and as easily walkable as possible.

Keep it simple

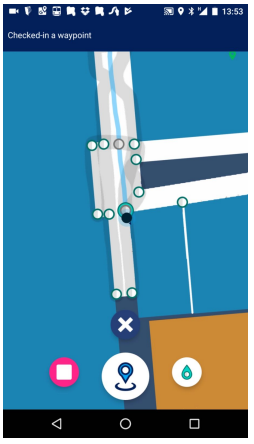
- Straight and short paths are easy to
  - Plan and collect
  - Detect mistakes from
- Check-in at about 3-7 waypoints per path
  - If something goes wrong, easy to discard and recollect
- Good distance for check-ins is about 5-20 m
- With experience you can start collecting longer paths



Start it simple.

Keep it systematic

- Fill the space with simple paths
  - Start from the easier ones
  - Fill the gaps by selecting different combinations of waypoints (add waypoints if needed)
- For corridors, using “lanes” about 1-2 m apart is an easy way to achieve good coverage
  - Preferably at least one path in both directions (helps with radio signals)
- Systematic and simple coverage of one area at a time also makes is easy to disable and enable paths in the web tool within certain area, e.g. when mapping around beacon installations

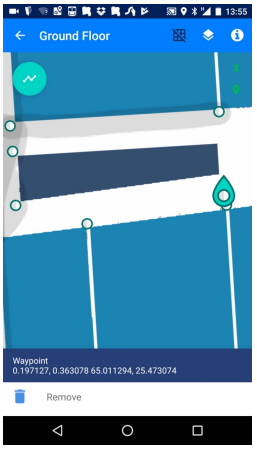


Be systematic.

Fixing waypoint errors

There are often errors in the floor plan or in the waypoint placement that are only revealed when arriving at the mapping site and beginning the mapping process. Use MC2 to

- Remove or move unusable waypoints that
  - Do not match reality
    - E.g. landmark missing or in different place
    - Use measurement tool in unclear cases
  - Are hard or impossible to access
    - E.g. obstructed by walls or other structures not visible in the floor plan
- Add new waypoints to easily recognizable and walkable locations



Remove or move incorrect waypoints.

If details are completely missing in some parts of the floor plan, you can use the measurement and grid tools and manually added physical markers (tape on the floor etc.) to create waypoint locations for the duration of mapping. This can somewhat alleviate the problems due to a low-quality floor plan.

Hard-to-access place.

Checking-in

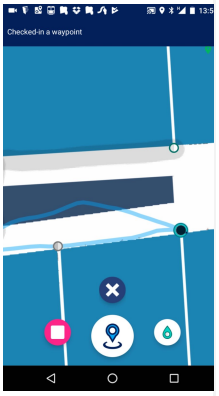
When mapping, MC2 estimates your path by using a PDR (pedestrian dead reckoning) and even selects the next waypoint automatically. However, the PDR is not perfect and may contain error due to

- Detecting too many or too few steps
    - Speed is estimated wrong
- Gyroscope drifting over time
    - Heading starts to accumulate error

Therefore checking into the waypoints from time to time is crucial to give MC2 the exact location of the mapper. In order to minimize the possible problems with the PDR and achieve the best map quality:

- Walk normally
    - Constant walking speed
    - Constant step length
    - Easily detectable steps
- Check-in regularly before gyroscope drifts too much
- When checking-in, make sure you are exactly in the waypoint location
    - Better than 0.5 m accuracy recommended
- Avoid too short distances between check-ins (< 5 meters or steps)
    - Irregular walking, e.g. couple steps at a time, may cause significant problems with speed estimation
    - When walking continuously through waypoints while checking-in, shorter check-in distances (2-3 m) are ok
- **Note:** It is a good practice use the manual waypoint selection
    - If the path is estimated wrong (e.g. speed estimate is off)
    - If there are close-by waypoints and it is uncertain if the automatic selection will select the correct one
    - Sometimes even when starting walking to the next waypoint, just to make sure the correct waypoint will be selected

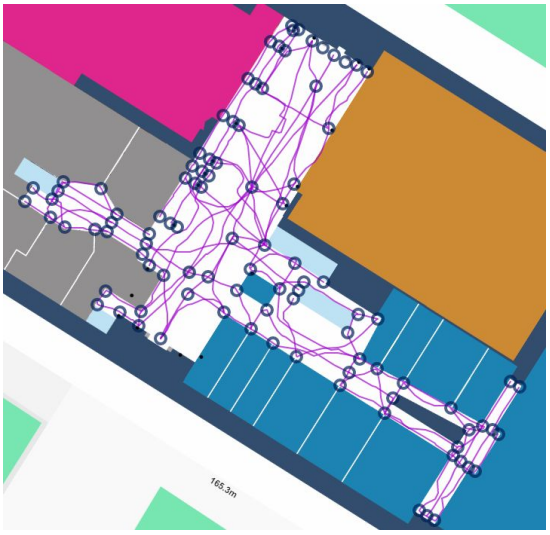
- **Note:** Discard incorrect paths
  - Path going over the walls is a clear indication that something went wrong (see figure)
  - If you have kept the paths short and simple, recollecting the path correctly will take less than a minute



Drifted path.

Coverage

In order to create an accurate map of the environment, the floor plan has to be mapped densely enough. This is determined by the area covered by the collected *paths*. In order to achieve good coverage



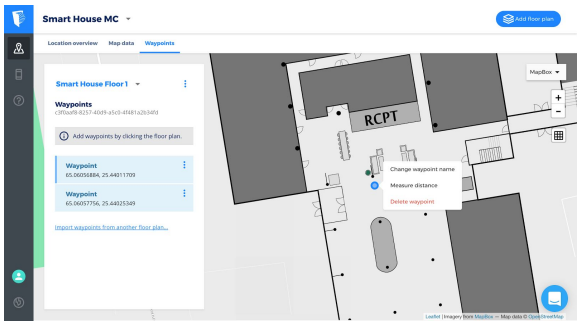
- First map the easy and simple paths in a systematic way
  - Corridors and main corners and pillars are good place to start
  - Use different combinations of waypoints to cover the easy areas with paths as systematically and evenly as possible
  - Add waypoints if needed to create new path possibilities
- Then look at the coverage (either in the web tool or MC2) and find the gaps in the mapped area
  - This is most likely in open spaces
  - Try to find paths to fill the remaining space
    - Look for non-walked paths between waypoints
    - Add simple curves to your paths to cover slightly different area
    - Cover most probable walking routes
    - Add waypoints if needed
- Good rule of thumb for path distances is about 2 m
  - Aim for this in corridors and other easily collectable places
  - In open spaces where there is less magnetic variation and exact location is not necessarily so important, the mapping can be somewhat more sparse (~3-4 m)
- The final and actual performance must be verified by generating the map and testing positioning

Other Useful Functionality Descriptions

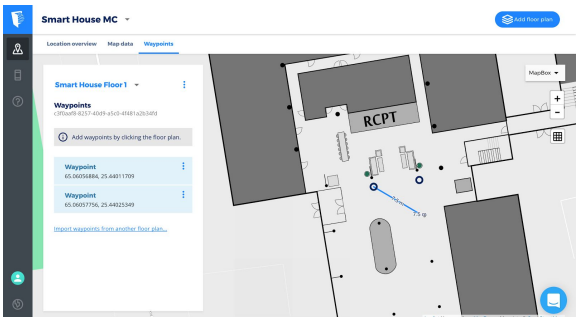
This part explains other useful optional functionalities of the web tools and the MapCreator 2 that can support the mapping process.

Distance Measurement Tools

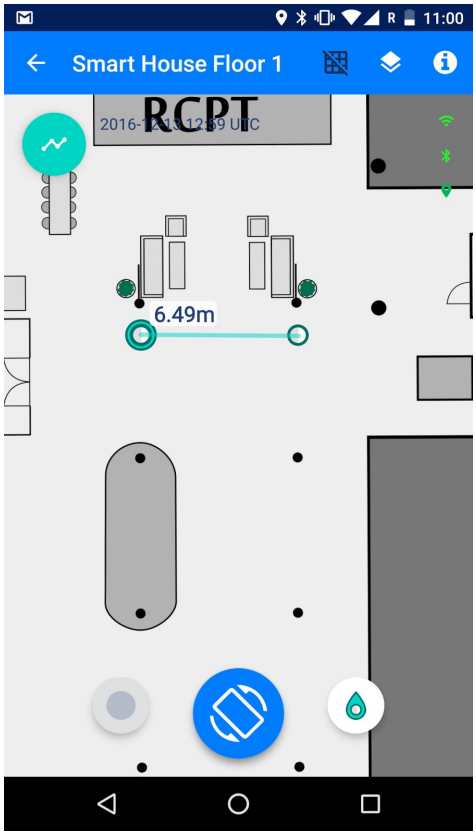
Both MapCreator 2 and the web tool support measuring distances on the floor plan. This can be helpful when making sure that the floor plan is aligned correctly in the real world and when placing the waypoints within a specific distance.



To measure the distance in the web tool go to "Waypoints" menu and click on a waypoint to show the waypoint edit functions. Select "Measure distance" to show the distances on the floor plan.



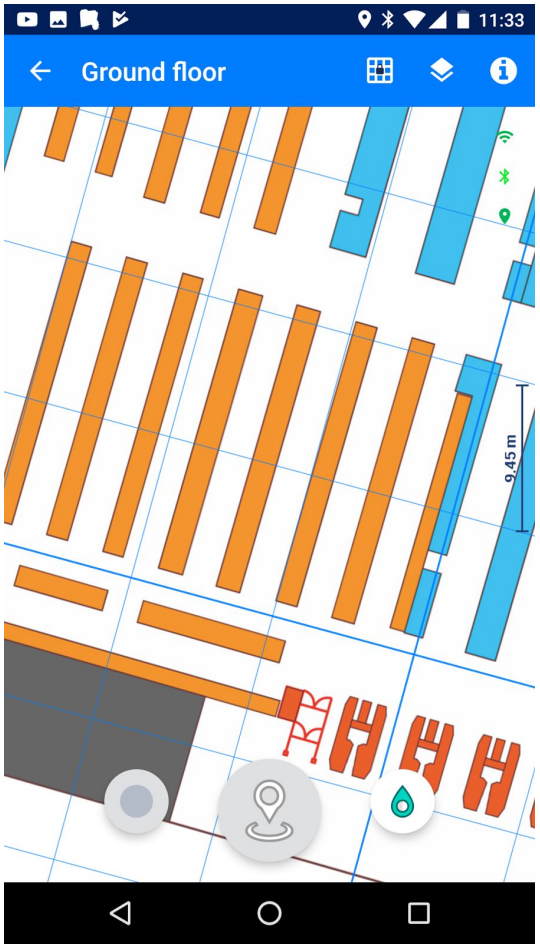
A measuring tape like tool will be shown with distance to the measured point. To end measuring click to show the edit functions once more and select "End measurement". To clear the measurement click once more on the empty floor plan and select "Clear measurements."



To measure the distance between two waypoints using MapCreator 2 simply select two of the waypoints by tapping them. To end the measurement tap on the floor plan to deselect the waypoints.

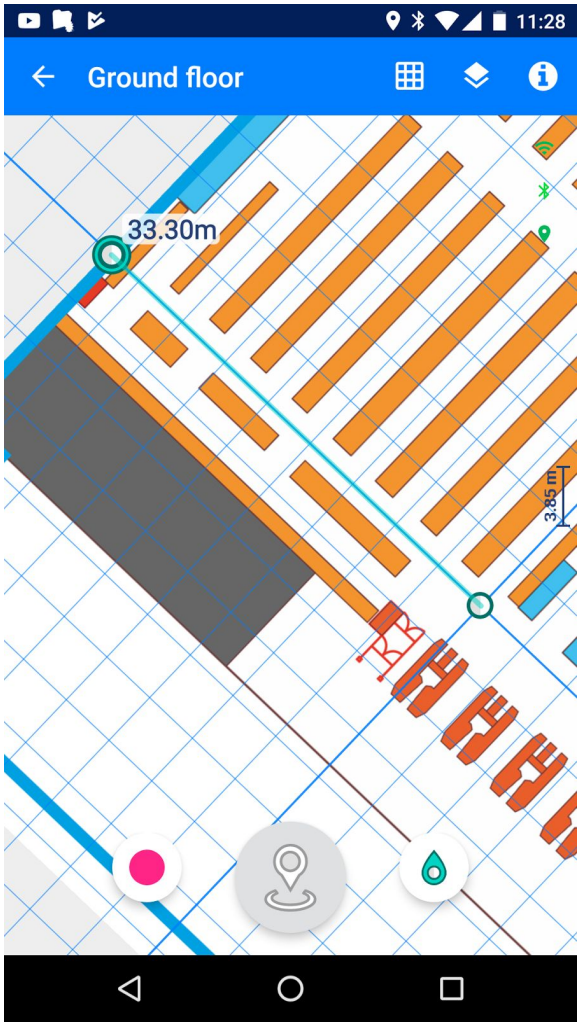
The Grid Tool

The grid tool makes it easier to place the waypoints systematically so that the paths will better cover the whole floor plan. It allows for easy snap-in placement of waypoints in straight lines with even spacing and grid-like alignment. It is particularly suitable for environments with evenly spaced structures, e.g. grocery store shelves.

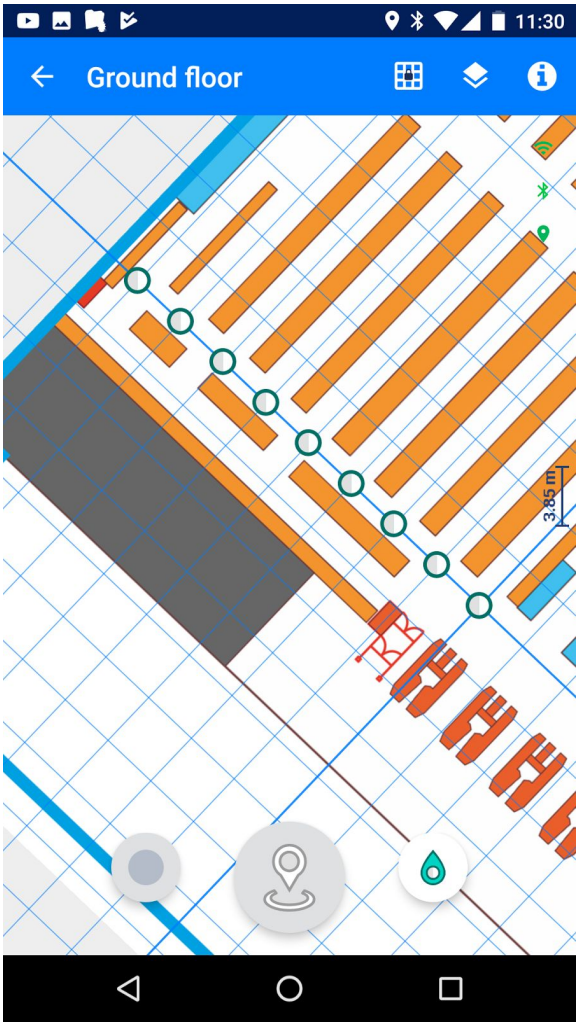


To show the grid tool tap on the grid icon at the top of the screen. The grid appears but the alignment of the grid can't be changed yet (locked mode indicated by the lock above the grid icon).

By tapping the grid icon one more time you can edit the alignment and cell size of the grid. Choose an alignment that best suits your needs. To lock the grid in place tap the icon until you see the locked-grid-icon in the previous image again.



The waypoints can be used to align the grid easily and accurately by selecting two waypoints while in the non-locked grid mode. After setting the grid orientation this way, you can still adjust the grid cell size to match the features in your floor plan.



Once you are happy with the grid alignment you can use it to place multiple waypoints fast and easy. The waypoints snap to the cell corners once dragged close by. After you have placed the waypoints you can hide grid by tapping the grid icon until the grid disappears.

Beacon Installation

Beacon installation overview

IndoorAtlas' hybrid solution works without beacons on ideal conditions but using beacons helps iOS to get first position quickly without walking. Beacons also improve Android performance where Wi-Fi environment is weak. Using beacons brings IndoorAtlas iOS positioning performance on par with IndoorAtlas Android positioning in the same environment. IndoorAtlas positioning on iOS requires significantly less beacons compared to a typical beacon-only positioning. On average, only 10-20% of beacons are required for the same positioning accuracy. Android can take advantage of Wi-Fi information, and thus it typically requires no beacons.

Key characteristics of IndoorAtlas indoor positioning service

- Only coarse beacon coverage is required
- Robust to small changes such as missing or out-of-battery beacon
- Low maintenance costs due to small number of required beacons and tolerance for small changes
- Similarly to Wi-Fi base stations, beacon locations are automatically deduced during the normal mapping flow; manual input is not required
- Low beacon advertisement frequency can be used increasing battery lifetime

Supported Beacons

Currently IndoorAtlas supports *iBeacon* and *Eddystone* beacon standards. Other standards will be recorded during mapping, but are not used during positioning. IndoorAtlas can utilize any beacon hardware as long as they are compatible with the above-mentioned standards.

Configuring Beacons

Beacon configuration parameters can be used to optimize the beacon coverage and battery life. IndoorAtlas positioning utilizes the beacons mainly for quick first location.

Beacon Type

To make beacon setup compatible with both IndoorAtlas iOS and Android SDK, configure the beacons as iBeacons or Eddystone beacons.

Advertisement Data

We suggest the following setup:

- Use the same proximity UUID for all your organization's beacons

- Set a unique major code for each Floor. For example, building A floor 1 has major 11, floor 2 has major 12 and building B floor 1 has major 21 and floor 2 has major 22.
- Set a unique minor code for each beacon under same the major code

If you order pre-configured beacons and you don't know how many beacons are placed in each floor, you can use a unique major/minor combination for every beacon. This makes harder to know which beacon is in which floor but it does not affect positioning accuracy. Using pre-configured beacons can save significant amount of time during installation.

Advertisement Frequency and Transmission Power

To receive a quick first location, we recommend having advertisement frequency of 1 Hz for the beacons. The most suitable beacon transmission power depends on the environment, beacon type, it's beam form and the beacon placement.

A rule of thumb:

- Depending on the case, beacon should be heard 15 - 30 meters away unobstructed
    - Beacon RSSI (signal strength) should be > -75 when standing nearby the beacon
- Lower transmission power
    - More accurate first location but requires more beacons.
    - Full beacon coverage requires more beacons because each beacon is heard on a smaller area
- Higher transmission power
    - Fewer beacons. but the first location is not as accurate
    - Full beacon coverage requires less beacons because each beacon is heard on a wider area

Similarly to beacon locations, transmission powers of the beacons are deduced during normal mapping flow: no manual input required.

Beacon Whitelisting

In order to avoid ambient (stationary beacons placed by someone else) or non-stationary beacons interfering with positioning performance, it is possible to whitelist beacon UUIDs that should be used during positioning. All other beacons are ignored. To whitelist beacons, please contact *IndoorAtlas support.*

Placing Beacons

At least one beacon should be heard at all times – the more beacons you hear, or smaller the beacon power, the better the initial position accuracy. For smaller locations, such as offices or small shops, it might be enough to add beacons to the walls of the building. If the location has large open spaces or the distance between walls is large, you might need to add beacons to some existing structures besides the walls, like pillars or shelves for example.

Area covered by one beacon depends on the beacon model and the configuration parameters. The place where the beacon is installed plays a significant role as well. Guidelines for placing beacons are:

- Cover the area as evenly as possible with the beacons.
    - For fast and accurate first fix on iOS, we recommend one beacon every 15 - 30m
- Good places for beacons
    - Pillars
    - Walls
    - On top of lighting (check that beacons are heard)
- Direction is important
    - When installed on pillars or other heavy structure, beacons can be heard only on the unobstructed side
    - Install beacons facing to the same direction, where possible – this makes it easier to evenly cover all areas
- Height is important
    - Place beacon high enough so that no one can grab them and so that the beacon signal is transmitted over small nearby objects or structures (shelves, furniture etc.)
    - Avoid installing higher than 5m to avoid beacons being heard too far away
    - Avoid installing beacons to the ceiling of multi-floor open areas
- When hiding beacons behind structures or on top of lamps, check before mapping that the beacon is heard sufficiently strongly in the vicinity of the beacon (RSSI >~ -75)
    - Use e.g., BeaconScanner app or map a few test paths with MapCreator 2 and check analytics (remember to disable the test paths in app.indooratlas.com if you make changes to the beacon installation after collecting the map paths!)
- *Beacon environment quality* available in “Draft map” in *app.indooratlas.com* is your friend!
    - Whole venue does not need to be green for good performance, but avoid large yellow/red areas – on these areas iOS users may experience longer time to first fix
    - Add beacons to yellow/red areas, re-map around the beacon and re-check the analytics

Depending on the beacon characteristics, a beacon signal may form a cone shaped beam directly out from its cover. This causes that:

- If this kind of beacon is installed on the ceiling, its beam is directed downwards and it’s heard only in a limited area underneath and in close proximity (5-10 meter radius)
- On the other hand, if such beacon is installed on the wall, its beam can be received rather far, 10-30 meters from the beacon but only in the limited direction, where the transmission beam is directed.

When deciding the placement, it is good to understand the characteristics of the beacon model you are installing.

Beacons near floor transitions

Installing beacons near floor transitions often makes them heard on multiple floor levels. This makes floor detection less reliable. Therefore, as mentioned earlier, installing beacons e.g. to the ceiling of open multi-floor areas is not recommended. Instead, try to install beacons near floor transitions so that they discriminate between floors as much as possible. In other words, try to ensure that the beacons are heard on one floor but not on the others. Use pillars and other physical structures to control where the beacons are heard.

Moving Beacons

Sometimes there can be a case, where an existing beacon needs to be moved. This can happen for example if you have accidentally mapped paths while having a beacon in your backpack. Moving a beacon can cause an issue if it remains on the map, as it can give invalid information to the positioning algorithm. Avoiding the issue is easy with the following steps:

1. *Change the minor code* (and major if changing floors) of the beacon you move. This way when it will be heard from its new location it will be recognized as a new beacon.
2. Place the beacon on its new location
3. Add mapping paths around the beacon. Coverage for the new paths does not need to be as dense as normal magnetic mapping, just map 10-15 meters around the beacon.
4. Disable paths near the old beacon location and remap those (Optional)

Note that the analytics of the old place won't change until you remap the old location (Step 4). Therefore, analytics might seem too optimistic, as the system thinks the beacon still exists in it's old location.

Mapping Workflow

Having read the *Configuring Beacons* and *Placing Beacons* above, you are equipped with a good idea of how many beacons you need for your deployment environment (if any) and where to place those on the floors. The most optimal solution, the lowest number of beacons and the best coverage, can be achieved by using an incremental approach. An incremental workflow could go through the following steps:

1. Plan the initial locations for the beacons by checking the floorplan
2. Install the initial beacons
3. Map coarsely
4. Analyze the beacon coverage

If necessary:

5. Install additional beacons to areas where the first fix is not accurate enough or beacon environment quality is bad

6. Record mapping paths around new beacons
7. Analyze the beacon coverage
8. Repeat from #5 if necessary

The same with more words:

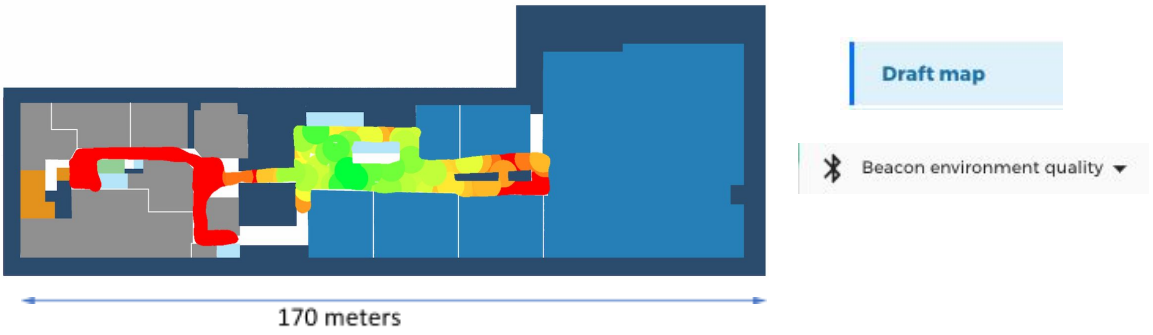
1. Configure a beacon and install it to one of you planned beacon locations, e.g. at an entrance. Use a beacon configuration app of your choice to check the proximity UUID, major code, minor code, signal strength of your beacon – just to make sure the beacon is configured correctly before making a more large scale setup. We suggest that the beacon RSSI (signal strength) should be > -75 when standing nearby (beacon should be heard 20-30m away).

2. (Optional) Map the location coarsely before installing any beacons – one path for each major aisle. **Remember to enable Bluetooth before starting the mapping** (MapCreator 2 warns if this is not the case). After the mapping is done, generate the map.

   This allows to check if there were any pre-installed beacons you might not be aware of. It happens often that e.g. shop owners in the mall have installed their own beacons or an infotainment display acts also as a beacon.

3. (Optional) Check the mapping results at app.indooratlas.com to verify the beacon status.

   Areas without beacon coverage can be easily seen on the map analytics. (Select the draft map and change to beacon environment quality view)

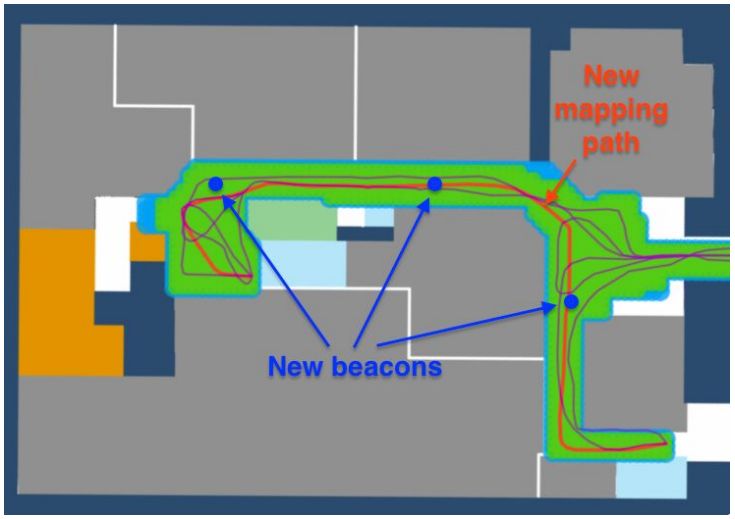


   The above is a real life example (a shopping mall floor) of the initial state. It was expected to have no beacon coverage at all. The analytics shows there is very good coverage on the mid part. On the other hand, the left side of the floor is missing beacons totally, as well as the very end of right side. In this case, the next step is to place one additional beacon on the right end and three beacons to left side. This will produce full coverage.

4. Install beacons to beacon-free areas or to the red areas as indicated by the analytics picture. We suggest uniform deployment, to cover the area evenly (see Placing Beacons).

5. Record mapping paths to the areas with new beacons to include them in the mapping data.

   After adding the new beacons, collect additional paths on the area where the new beacons were added. This inserts the beacons on the positioning map. Remember to generate the map after mapping.



Picture shows the places of the newly added beacons, old mapping paths and the new path we added in the example case. In this case the signal strength of the beacons and the placement added full coverage to the target area. There was still a small empty spot left on the bottom right of the map but it was thought to be OK, since it's not expected to get any sessions started there. The dot will follow there accurately by magnetic data.