Indoor Positioning

Installation Guide

Version 1.0

Important Information

Notices

Topics:

This section contains document notices.

Legal Notices

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Contents

Chapter 1

Overview

This guide explains how to install, configure and verify the functionality of the HERE Indoor Positioning system.

This guide covers:

- Preparing the installation
- Installing the HERE Indoor Positioning system
- Configuring the components of the HERE Indoor Positioning
- Verifying that your installation is working correctly
- Important technical information about the HERE Indoor Positioning

For instructions on how to use the HERE Indoor Positioning once it has been set up, see the *HERE Android SDK Developer's Guide Premium Edition* or *HERE iOS SDK Developer's Guide Premium Edition* for details.

Chapter 2

Workflow

Topics:

This chapter summarizes the workflow required to prepare the venue and collect radio data at the venue, as well as to configure and verify the functionality of the HERE Indoor Positioning system.

Preconditions

To use HERE Indoor Positioning, you need the following:

- HERE Mobile SDK Premium for Android or iOS
- HERE Mobile SDK `license-key`, `app-id`, and `app-code` from the HERE Developer Portal or from HERE directly
- HERE Indoor Radio Mapper in case you wish to create indoor positioniong coverage by yourself. The tool is delivered as part of the HERE Mobile SDK package.

With the HERE Mobile SDK and corresponding authentication credentials, you are fully equipped to use HERE Indoor Positioning inside venues where HERE already has community indoor positioning coverage. If this is your intent, you can skip to *Using HERE Mobile SDK and Indoor Positioning*.

Preparing the Venue

You can use WiFi or Bluetooth beacons to support HERE Indoor Positioning.

If you plan to use an existing WiFi or Bluetooth deployment to support HERE Indoor Positioning, you can proceed to *Surveying your Site*. If you plan to use an existing WiFi infrastructure, make sure that the WiFi coverage is ubiquitous at your venue with preferrably more than five physical WiFi access points observable throughout the venue. Please note that more than ten WiFi APs is preferred for the optimal system performance. The higher the number of WiFi access points, the better the system performance.

If you plan to use Bluetooth beacons, we recommend that you familiarize yourself with the section *Beacon Configuration and Ordering* to understand the characteristics we require for beacons.

If you plan to deploy Bluetooth beacons like Eddystones or iBeacons, now is the right time to do so. If you are building an iOS application, Bluetooth beacons are mandatory. See sections *Beacon Configuration and Ordering* as well as *Beacon Deployment* for complete information on beacons, ordering them, and deploying them.

Collecting radio data at your site

The HERE Indoor Radio Mapper, which is delivered as part of the HERE Mobile SDK, is an Android application that is used to collect the Wifi and Bluetooth radio environment at a venue.

When you launch the HERE Indoor Radio Mapper, you need to log in with your HERE Account credentials after which you can access all the HERE Venue Maps you are eligible to use. Firstly, this may include, depending on your subscription, publicly available HERE Venue Maps. You are free to collect data at any of those venues, provided that you have permission to do so. Moreover, if you already have HERE Private Venue Maps associated with your account, those maps are shown in the Indoor Radio Mapper landing page automatically.

You can also use your own image-based custom indoor maps, provided you import those maps to the HERE Indoor Radio Mapper and calibrate the images with Latitude and Longitude coordinates. Refer to the HERE Indoor Radio Mapper User Guide for further details.

The process of collecting radio data in a part of a building consist of:

1. Displaying the appropriate floor plan (HERE Venue Maps or your own custom indoor map) in the HERE Indoor Radio Mapper.
2. Walking, following a straight-line path, and clicking on the plan/map to indicate your location at regular intervals.

The result is a record of radio samples that are geo-referenced to the correct location and floor in the venue.

The above process must be repeated in each part of the building in which you want to set up indoor positioning. The time required to collect the data for a whole building depends on the size and internal structure of the building, but the process needs to be completed only once per venue, provided that there are no significant changes in the radio environment. The document HERE Indoor Radio Mapper User Guide provides detailed instructions and practical advice on how to use the tool.

HERE Indoor Positioning is a cloud-based system. This means that if there are multiple instances of the HERE Indoor Radio Mapper collecting radio data for the same account, all the instances see and can manipulate the radio data. The radio data from all the instances is combined to create the radiomap to support indoor positioning. Importantly, in the testing phase all the instances test the same positioning data.

As an example, the image below shows the radio samples for a single WiFi access point in a single floor in a venue. The data has been collected along the corridors. Color denotes the signal strength, with blue indicating low signal strength and yellow high signal strength. The data shown is very typical – the signal from the access point can be heard quite extensively on the floor where the access point

is installed. Similar patterns are obtained for each WiFi access point and/or Bluetooth beacon on each floor in the building. This is the starting point for the creation of a radiomap in the HERE Cloud.

Figure 1: Radio data for one WiFi Access Point collected with HERE Indoor Radio Mapper

Testing the radio data at the site

You can test out HERE Indoor Positioning a few minutes after you have uploaded the collected radio data to the HERE Cloud. The HERE Indoor Radio Mapper will notify you once the data has been processed and testing can commence. Upon entering the test view, you can walk around the building and you can see HERE Indoor Positioning in action. In addition to the real-time positioning testing,you can also collect a *test track* allowing you to get quantitative feedback on the positioning quality at the venue.

In case you detect that some areas have problems with positioning or insufficient radio data was collected there, you can easily collect further radio data at this time and test again.

Publishing the radio data

Once you are happy with the positioning performance when you walk around the building and run the test track, you need to publish the radiomap to production. Once publishing is complete the positioning data is available for the HERE Mobile SDK. Please refer to the HERE Indoor Radio Mapper User Guide for further details on publishing.

Using HERE Mobile SDK and Indoor Positioning

HERE Mobile SDK offers an access to a rich set of APIs including positioning, mapping, indoor positioning and indoor mapping.

For positioning, there is a clean, single simple API that provides positioning information with the best available technology, depending upon *business features* in your subscription. The positioning information can be based on data from satellites (GPS, GLONASS, etc.), crowd-sourced global WiFi data and cellular networks or WiFi and/or Bluetooth-based indoor positioning.

In summary, the positioning features of the HERE Mobile SDK include:

- Downloading radiomaps from the HERE Cloud – once the radiomap resides in the device, the device can position itself without network connectivity. The position calculation takes places in the device reducing latencies, improving the positioning accuracy and keeping the location information private within the device.
- Automatic radiomap management – when a device enters a new building or radiomaps have been updated in the HERE Cloud, the new or updated radiomaps are downloaded to the device automatically. Also, old radiomaps are automatically cleaned.
- Automatic selection of the best available positioning technology – selection is automatic between WiFi and Bluetooth radiomaps (if both are available) and between indoor and outdoor positioning methods, if allowed and enabled in your HERE Mobile SDK license.

The API provides access to the following information related to indoor position:

- Location (latitude and longitude)
- Estimated location uncertainty in meters
- Floor level (floor index)
- Building name and ID:
    - If you use HERE Venue Maps, the building name and building ID are static and automatically assigned and managed by HERE
    - If you use an image-based custom indoor map, you can set the building name when aligning the indoor map to the Latitude-Longitude coordinate system in HERE Indoor Radio Mapper. The building ID is generated automatically from the set name.

- Positioning technology (Bluetooth, WiFi)

The HERE Mobile SDK package also contains a rich set of code snippets that allow you to get started with testing and creating your own application fast.

Testing your Application

If you wish to test the HERE Indoor Positioning with a standard setup, refer to *Testing the System*.

Chapter 3

Beacon Configuration and Ordering

Topics:

This section specifies the requirements and configuration for Bluetooth beacons that we recommend for use with the HERE Indoor Positioning system. Although HERE Indoor Positioning is compatible with other configurations, the recommended configuration provides the best level of performance.

Both Eddystone and iBeacon configurations are covered, but we recommend to use Eddystones, because their standard defines and supports telemetry messages for beacon monitoring.

General Requirements

The following table specifies the general requirements for the beacons and their casing.

Table 1: General requirements

Requirement	Value
Lifetime	The required lifetime depends on the use case. However, with our recommended configuration, 2000 mAh should be enough for a lifetime of three to five years.
Antenna	Omnidirectional
Attachment	Sticky tape, screw or cable tie
Environment protection	Depends on the deployment environment • IP65: dust-tight, water resistant • IP66: dust-tight, waterproof • IP67: dust-tight, fully waterproof
Labeling	The beacon identifier must be visible on the casing for maintenance reasons. The beacon identifier consists of an Eddystone UID or an iBeacon UUID, a Major ID, and a Minor ID. In addition, the beacon MAC address needs to be visible. Both the beacon identifier and MAC address are expressed in the hexadecimal notation.

Eddystone Beacon Configuration

The following table specifies the detailed configuration that an Eddystone beacon needs to fulfill.

Table 2: Eddystone configuration requirements

Parameter	Value
Eddystone Namespace	See *Assigning the Eddystone Namespace*.
Eddystone Instance ID	See *Assigning the Instance IDs*.
UID advertisement power	0 dBm.
UID advertisement interval	852 ms.
Telemetry advertisement power	+5 dBm.
Telemetry advertisement interval	60000 ms, resulting in 1/70 interleaving of the telemetry message.
Telemetry contents	At least battery status

Parameter	Value
Mode	Non-connectable advertisement (broadcast only).
Other transmissions	Not allowed; no URL advertisement or other beacon modes like iBeacon packets.
Battery optimization	The beacon must not change its transmission power or interval in any scenario.

Assigning the Eddystone Namespace

The Eddystone Namespace is a part of the Eddystone Unique Identifier (UID), which consists of a 10-byte Namespace (20 hexadecimal digits) and 6-byte Instance ID. A company should have only one Namespace in use.

The Namespace can be derived from the company website URL with a suitable hashing algorithm, and if necessary, cropping the resulting hash. For example, we use, in our Eddystone Namespace, a hash of here.com:

```
ripemd128Hash (here.com) = 4adbd94ea8fd8a29ac48815dee7e55f3
```

The algorithm shown is for illustrative purposes only; you can use other algorithms too.

The 10-byte Namespace is obtained by removing the six bytes in the middle (underlined below):

4adbd94ea8fd8a29ac48815dee7e55f3

There are many ways to calculate hashes. One example is via command line, you can run the following command:

```
echo -n "{YOUR_COMPANY_WEBSITE_URL}" | openssl sha1
```

Note: The above command has been verified on Linux, Mac OS X, and Windows (with MinGW).

Assigning the Instance IDs

While the Namespace is static for all Eddystones belonging to the company, the Instance ID must be unique in order to have a unique UID for each beacon.

The Instance ID is a 6-byte number with a range of $[0,2^{48}-1]$. The Instance ID can simply be a running number. However, some book-keeping is necessary in order to know the number to start at for the next order. When ordering beacons, it suffices to state the first Instance ID and instruct that the number increases by one for each beacon.

iBeacon Configuration

The following table specifies the detailed configuration that the iBeacon beacon needs to fulfill.

Table 3: iBeacon configuration requirements

Parameter	Value
iBeacon UUID	See *Assigning iBeacon UUID*.
iBeacon Major and Minor ID	See *Assigning Major and Minor ID*.
iBeacon advertisement power	0 dBm.
iBeacon advertisement interval	852 ms.
Mode	Non-connectable advertisement (broadcast only).
Other transmissions	Not allowed.
Battery optimization	The beacon must not change its transmission power or interval in any scenario.

Assigning the iBeacon UUID

The iBeacon UUID is part of the iBeacon identifier, which consists of a 16-byte UUID (32 hexadecimal digits) and Major ID and Minor IDs, which are both 2 bytes long.

This UUID can be derived from the company website URL with a suitable hashing algorithm, and if necessary, cropping the resulting hash. For example, we use, in our iBeacons UUID, a hash of here.com:

```
ripemd128Hash (here.com) = 4adbd94ea8fd8a29ac48815dee7e55f3
```

This hash algorithm produces the 32-hexdigit long UUID directly. The algorithm shown is for illustrative purposes only; you can use other algorithms too.

There are many ways to calculate hashes. One example is via command line, you can run the following command:

```
echo –n "{YOUR_COMPANY_WEBSITE_URL}" | openssl sha1
```

Note: The above command has been verified on Linux, Mac OS X, and Windows (with MinGW).

Assigning the Major and Minor ID

While the UUID is static for all iBeacons belonging to the company, the combination of Major and Minor ID must be unique for each beacon. These IDs are numbers ranging from [0, 65535].

The Major ID can be used to group iBeacons into sets, while the Minor ID identifies the iBeacon in that particular set.

When ordering beacons, you need to define the Major IDs and how many beacons you want to have for each Major ID set. Remember to document your orders so that you know, from which Minor ID to start from, in case you need to order more beacons to an existing Major ID set. When ordering

beacons, it suffices to state the first Minor ID for each Major ID and instruct that the Minor ID increases by one for each beacon.

Estimating the Required Amount of Beacons

You can estimate the number of beacons you need using the dimensions of your building in meters as input to the formula:

$$\text{number of floors} \times \left(\left\lceil \frac{width}{10} \right\rceil + 1\right) \times \left(\left\lceil \frac{height}{10} \right\rceil + 1\right)$$

For example: if your building has three floors and the blueprint is 81 x 103 meters, then you need approximately 360 beacons.

Reference suppliers

The following table specifies the suppliers that we have used for our reference deployments.

Table 4: Suppliers

Supplier	Product	
Minew Technologies, China *http://minew.en.alibaba.com/*	product name "c1"	2 AAA batteries (1000 mAh, few years lifetime(1)) strictly for indoor-spaces only
	product name "i3"	2 AA batteries (2000-3000 mAh, 5 years lifetime(1)) IP65 waterproof
Bluvision, USA *http://bluvision.com/*	product name "iBeek"	2600 mAh battery (more than 5 years lifetime(1)) IP67 fully waterproof Can be equipped with multiple sensors including light, accelerometer, and magnetometer.

(1) According to the supplier's specifications

When ordering, you should provide the supplier with the following information:

- General requirements and details about the deployment environment

- Configuration requirements
- Namespace and Instance ID definitions
- Whether you require a pre-installed battery and a sealed case

Chapter 4

Beacon Deployment

Topics:

This section provides guidelines for Bluetooth beacon deployment for the HERE Indoor Positioning system. Using these instructions, you can complete the installation according to the HERE recommendations. This is essential in order to achieve the expected positioning performance.

See also *Beacon Configuration and Ordering*. Radio environment mapping with the HERE Indoor Radio Mapper tool is described in the HERE Indoor Radio Mapper User Guide.

Deployment Planning

Deployment requires proper planning prior to installation. We recommend the following for your deployment:

- Only use the beacon types recommended by HERE. Use the same beacon type for your whole deployment.
- Beacons should be distributed evenly with a grid size of approximately 10 meters. However, a grid size of 8 to 12 meters should be sufficient for most buildings.
- Deploy across the whole area, without leaving any gaps. Also ensure that the building edges are covered with beacons.
- For staircases, a good principle is to install one beacon on every floor and one beacon on the intermediate floor between two sections of stairs, if available.
- For large spaces (over 15 m x 15 m) that do not contain pillars or other structures suitable for beacon fastening, consider installing beacons to the ceiling to reduce inter-beacon distances.
- In office spaces, consider installing a beacon in each room, to have sufficient radio coverage in each room.

The following figure shows an example beacon deployment in a part of the building. The beacons have been installed along the building edges as well as in most of the meeting rooms. In open areas the beacons have been fastened to the pillars.

Figure 2: Example Beacon Deployment

Beacon Installation

When installing beacons, you should consider the following factors:

- **Location** – To maximize the area that a beacon covers, install the beacon in a way that nearby obstacles do not block its radio signals.

  For example, consider on which side of a pillar the beacon should be placed. One option is to have two beacons on the adjacent sides of the pillar to cover the area better with radio signals.

> **Important:** Beacons must not be installed on any moving structures like elevators or any such mobile platforms. Install beacons on fixed structures that cannot be moved; the beacon position must be static all the time.

- **Height** – Install beacons at a height where neither furniture nor crowd can block its signals. Typically 2.2 m from the floor should suffice. In public areas where there is a risk of vandalism or theft, beacons should be installed slightly higher, between 2.5 to 2.8 m. For walls, keep a minimum of 5-cm clearance between the beacon and the ceiling.
- **Orientation** – Check the beacon antenna pattern documentation and orient the beacon in such a way that it provides the best signal for the area that the beacon should cover. The HERE recommended beacons have omnidirectional antennas, so the beacon orientation is not critical.
- **Fastening** – Double-sided mounting tape can be used to fasten small beacons. The tape needs a clean and sleek surface, so we recommend attaching beacons on glass or metal rather than on unfinished concrete. Removing an installed beacon from painted wall or wallpaper may damage the surface. If tape does not stick to the mounting survace, you can use screws and/or glue to get solid fastening for beacons. Instead of tape, glue or screws, it is also worthwhile to check, if cable ties can be used to install beacons. Cable ties are fast to use and also easy to cut, when removing the beacons.
- **Conditions** – Installation should be done in daytime, in dry and warm conditions, if possible. Cold and wet conditions may have an impact on fastening, especially when using tape. Pay particular attention when mounting beacons in cold areas (below 0°C) such as parking garages.

Initial Beacon Deployment

Perform proper planning based on the guidelines provided in *Deployment Planning*. It is advisable to plan the deployment well before-hand by visiting the venue. Once planning is complete, a larger group of technicians can be used to deploy the beacons fast.

You may need to make adjustments to the planned deployment for many reasons, e.g. there might be non-accessible areas. In these cases technicians installing the beacons should be familiar with the planning guidelines so that adjustments can be made on-the-fly.

After the deployment, perform radio mapping and positioning testing using the HERE Indoor Radio Mapper tool. Before mapping make sure there are no unused beacons in the area.

Approximately one week after installing the beacons, walk through the deployment area and inspect the beacon fastenings at least visually to verify that they are still fastened properly.

Complementing the Beacon Deployment

If there is a need to install additional beacons, follow the guidelines from *Deployment Planning* and *Beacon Installation*. After the installation, perform radio mapping and positioning testing in the area using the HERE Indoor Radio Mapper tool.

Replacing Beacons

Sometimes beacons may fail, get lost or stolen. When you have located a failed beacon, remove it carefully to avoid damage to the underlying surface. Clean the surface from any old tape or glue and fasten the new beacon in the same position and/or direction. Perform radio mapping and positioning testing in the nearby area using the HERE Indoor Radio Mapper tool.

Storing Beacons

Beacons should be stored properly if they are active, like transmitting Bluetooth signals. Unused active beacons should not be detectable in the deployment area. For this reason, consider the following guidelines:

- Do not leave any unused beacons lying around on tables or anywhere else.
- Do not store any spare active beacons in the same building where the deployment was done.
- Find a proper place for the leftover beacons, such as a storage location away from the building, preferably in a metal container in order to block electromagnetic radiation.
- If unused beacons are not stored carefully, the positioning system may be unreliable or its performance may degrade.

Important: Active beacons continuously transmit Bluetooth signals. It is extremely important that there are no unused active beacons in the building. Even though the transmitting power is low, it is possible for beacon signals to be received through ceilings and walls. Spare beacons that may be moved from one place to another may disrupt the indoor positioning service.

Chapter 5

Testing the System

Topics:

This section describes how to verify the HERE Indoor Positioning system end-to-end functionality and performance.

Environment-Setup

This section describes how to set up the environment for WiFi-based and Bluetooth beacon -based positioning.

WiFi-based Positioning

Note: Due to platform limitations in iOS, WiFi-based positioning is only supported on Android devices.

Testing for WiFi-based indoor positioning can be done using the existing WiFi infrastructure in an office, shopping mall, and so on. The only requirement is to have sufficient Access Point (AP) density in your test site.

The following table specifies the recommended WiFi AP densities in different infrastructure settings.

Table 5: Recommendations for WiFi AP Density

Infrastructure type	Recommended WiFi AP density	Example
Managed	More than 10 APs observed per scan	An office building with a Cisco-provided connectivity solution, for example.
Mixed	Between 10 and 20 APs observed per scan	A shopping mall with some type of managed WiFi AP infrastructure.
Ad-hoc	More than 20 APs observed per scan	An apartment building with an AP in each apartment; deployment not optimized for the overall connectivity.

The purpose of the above table is not to limit venues, where the HERE Indoor Positioning system can be deployed. We are simply stating the conditions, in which the indicated performance figures can be obtained. In case the AP density is lower than the value indicated in the table above, the performance targets may not be met.

HERE Indoor Positioning works better with a more varied WiFi AP landscape. Now, it may happen that although there is virtually a plethora of observable APs, the positioning performance is not as expected. This may be because of the MIMO APs, meaning that a single physical AP acts as multiple logical APs. Such APs typically do not introduce the required variability to the signal environment.

The following table specifies the minimum area, in which the WiFi-based positioning can be tested.

Table 6: WiFi-based positioning setup

Parameter	Value	Comments
Area to be covered per floor	30m x 30m	
Number of floors	Two or three	One floor is adequate if floor detection is not tested

Bluetooth Beacon–Based Positioning

Note: Bluetooth beacon (iBeacon or Eddystone) deployment is mandatory for testing HERE Indoor Positioning on iOS. The same beacon deployment is suitable for testing on Android as well.

The following table describes the recommended beacon deployment parameters. While any suitable Eddystone or iBeacon deployment can be used, we recommend to set up the deployment with Eddystone beacons having the configuration as specified in *Beacon Configuration and Ordering*.

Table 7: Bluetooth Smart –based positioning setup

Parameter	Value	Comments
Area to be covered per floor	30 m x 30 m	
Number of floors	Two or three	One floor is adequate if floor detection is not tested
Number of beacons	16-25 per floor	Beacons deployed in roughly a rectangular grid with dimensions ranging from 8 m x 8 m to 12 m x 12 m. This typically results in having five to ten beacons observable at any given location within the test area.

Proper beacon deployment is essential and it is important to invest time on planning the placement of beacons. Beacons must not be moved during or after the radio mapping procedure. Refer to *Deployment Planning* for deployment instructions.

Radio Data Collection in the Test Environment

The purpose of conducting radio data collection is to map the signal strength environment in the test area. Since signal strength information is used in positioning, radio data collection needs to be done prior to positioning.

Setting up the HERE Indoor Radio Mapper

The following steps are required to set up the tool:

- Log in with your HERE account credentials.

- If your account has Private HERE Venue Maps, verify that these maps are visible in the landing screen. Otherwise, contact HERE Technical Support.
- If you plan to collect data on a HERE Venue Map, you are good to go. Otherwise, you need to align the images of the building floor(s) to the Latitude/Longitude coordinate system as described in the HERE Indoor Radio Mapper User Guide.

Refer to the *FAQ* for details on the devices that we recommend to use in the data collection.

Radio Data Colletion

Perform the radio data collection separately for WiFi and/or Bluetooth radio environments as instructed in the HERE Indoor Radio Mapper User Guide. The data should be available for testing in the HERE Indoor Radio Mapper tool in the matter of minutes.

Once the radio data processiong is complete in the HERE Cloud, positioning can be tested with the HERE Indoor Radio Mapper tool as shown in the HERE Indoor Radio Mapper User Guide.

Test Track

Collect the test track separately for WiFi and/or Bluetooth radio environments as described in the HERE Indoor Radio Mapper User Guide. The test track must cover all of the floors, where WiFi and/or Bluetooth deployment has been setup, so that floor change scenarios are also captured in the track. Moreover, if you have collected radio data outside of the venue, the test track should also include indoor-outdoor changes in order to ensure that the indoor/outdoor changes take place appropriately. Refer to the HERE Indoor Radio Mapper User Guide for details on collecting a test track.

Analyzing the Results in the Indoor Radio Mapper Tool

Once the test track has been collected, you can analyze the track against the collected radio data as described in the HERE Indoor Radio Mapper User Guide. The following statistics will be shown:

- Mean accuracy
- Floor detection rate

The following results are considered to be acceptable:

- Mean accuracy better than five meters
- Floor detection rate more than 80%

Note: If your radio environment does not achieve the recommended WiFi AP or Bluetooth beacon density, the positioning accuracy and floor detection rates may be suboptimal.

Testing the HERE Mobile SDKs

Pre-requisites

Prior to testing, the following requirements must be met:

- HERE Mobile SDK for Android or iOS Premium version 3.2.2 or greater in your development environment.
- In the HERE Mobile SDK manifest:
  - HERE Mobile SDK for Android or iOS Premium License key that has HERE Indoor Positioning business feature(s) enabled.
  - Application ID (`app_id`) and Application Code (`app_code`) for Android and/or iOS applications.
- Collected radio data published to the production that the HERE Mobile SDK accesses. Refer to the HERE Indoor Radio Mapper User Guide for details on publishing the radio data.

Smoke test application (Android)

The HERE Mobile SDK for Android includes example code in the `BasicPositioningSolution` tutorial to get your first Indoor Positioning application up and running. Refer to the SDK examples for further information.

If your current location has indoor positioning coverage and you have everything setup correctly, an indoor-based position is displayed on the screen. The application shows the following:

- Location in Latitude and Longitude coordinates. If possible, verify that these match with your test site location.
- Position indicator on a map
- The floor level
- The building ID
- Location type is "INDOOR"

If these details are visible, that means the SDK smoke test is successful.

Smoke test application (iOS)

Setup the `HEREPositioningTutorial` application located in the sample-apps folder within the HERE Mobile SDK for iOS package. The folder contains readme.txt that helps you to get the application up and running. After that refer to the Positioning section in the *HERE iOS SDK Developer's Guide Premium Edition* to get HERE Indoor Positioning working.

Chapter 6

Radiomaps and Business Features

Topics:

HERE Indoor Positioning supports different types of radiomaps. A radiomap is the description of the radio signal strength landscape in a venue and is generated based on the user-collected radio data. The radiomaps and their usage are related to the available business features and indoor map types.

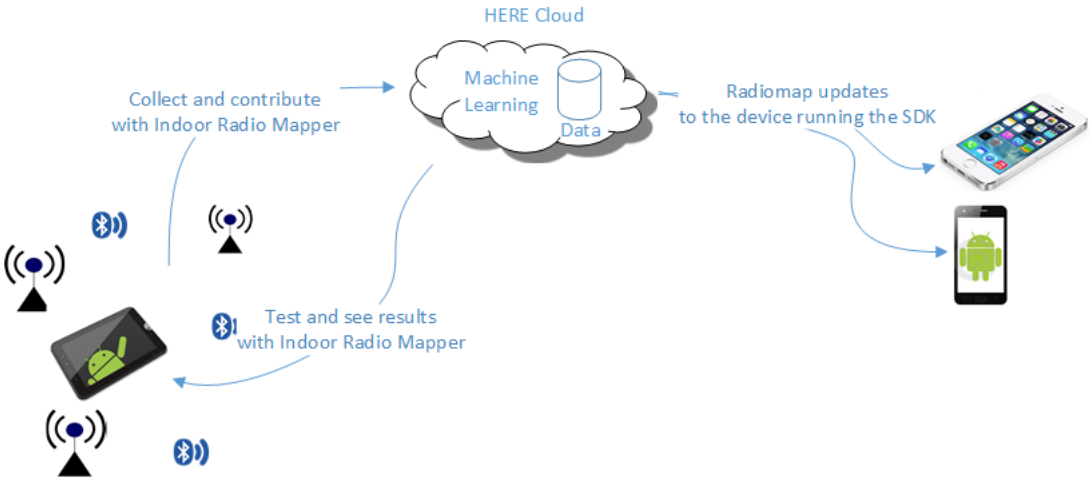
The very high level view

Conceptually, HERE Indoor Positioning can be reduced to three main components:

- HERE Indoor Radio Mapper that allows the user to collect, test and publish radio data at venues
- HERE Cloud service that stores and processes the radio data
- HERE Mobile SDK that allows applications to acces indoor positioning information

The following figure offers a conceptual representation of the data flows involved in HERE Indoor Positioning.

Figure 3: High level data flow in HERE Indoor Positioning



Radiomaps in HERE Indoor Positioning

There are three types of radiomaps in HERE Indoor Positioning:

- *Draft Radiomap* – your own sandbox for testing and trialing
- *Private Radiomap* – a production radiomap containing your private radio data
- *Community Radiomap* – a production radiomap shared by all the HERE Mobile SDK users

Radio data collected with the HERE Indoor Radio Mapper is initially included only in the Draft Radiomap when uploaded. Moreover, the HERE Indoor Radio Mapper always accesses the Draft Radiomap when testing positioning. Once you are happy with the performance, you can simply publish the Draft Radiomap to the production after which applications using HERE Mobile SDK can

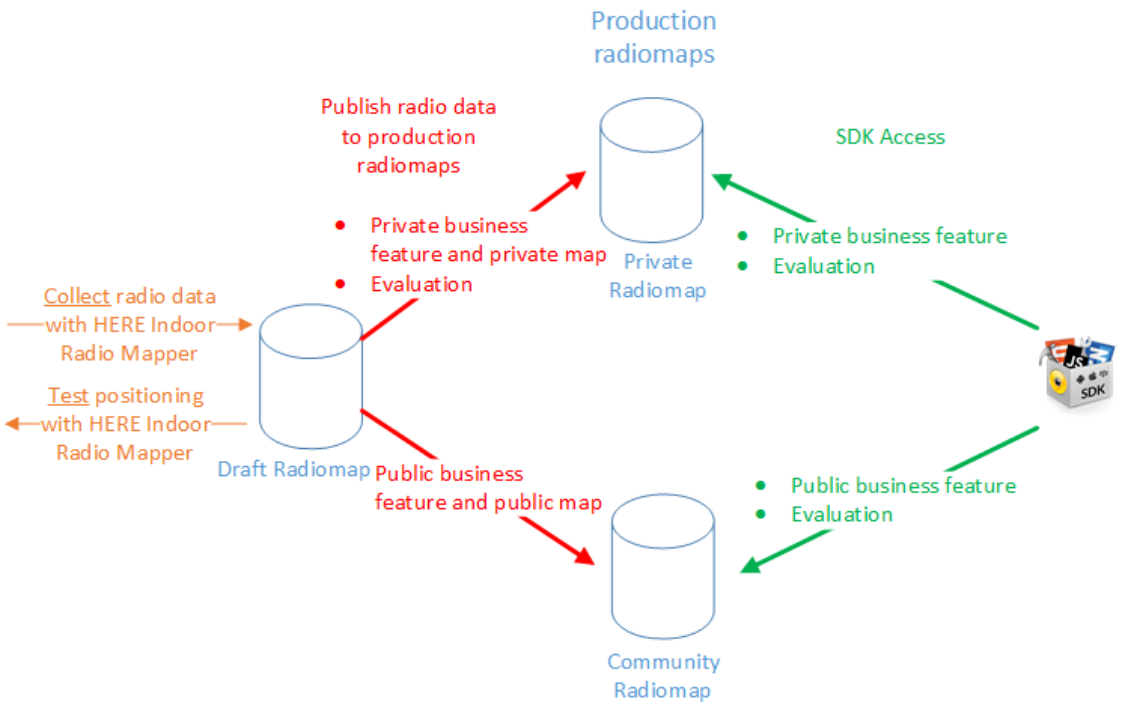
access the indoor positioning data. Having done this, you are free to continue working with the Draft Radiomap without affecting the positioning data utilized by the HERE Mobile SDK users.

The HERE Mobile SDK accesses the production radiomap(s). The production radiomap(s) in use depend(s) on the Business Features enabled in your subscription (see *Business Features*).

Radio data flows across radiomaps

The diagram below presents the radio data flows across the radiomaps conceptually. Note that items of radio data can be discarded during the radiomap generation, if, for example, the algorithms that process the radio data detect that the data is too noisy.

Figure 4: Data flow high level view



The important concepts of the radio data flow are:

- The Draft Radiomap is intended for testing. It allows positioning system operators and developers to run trials on the system with no impact on the positioning performance for the end users that use production radiomaps. The Draft Radiomap is account-specific, which means it is private to the account owner. During testing, the HERE Indoor Radio Mapper always accesses the Draft Radiomap. Also, when the data is collected with the HERE Indoor Radio Mapper and uploaded to the HERE Cloud, the data is automatically assigned to the Draft Radiomap.
- The production radiomaps are the ones accessed by the end-user applications, i.e. the applications powered by the HERE Mobile SDK. To enable indoor positioning to these

applications, the Draft Radiomap needs to be published. After publishing the Draft Radiomap and production radiomaps get synchronized.

- There are two production radiomaps the difference being in their privacy level. The first one, the Community Radiomap, is available for all the HERE Mobile SDK users that have a license to access that radiomap. The other one, the Private Radiomap, is only for a specific set of Application IDs associated with your account. The Private Radiomap cannot be accessed by other customers.
- Once the radio data is being published, the production radiomap to which the data goes to is controlled by your subscription and the type of the indoor map used for the radio data collection.
- The Community Radiomap only accepts radio data that has been collected using Public HERE Venue Maps. Note that in case your subscription does not have Public Indoor Positioning feature, the radio data collected using Public HERE Venue Maps cannot be published to production.
- The Private Radiomap only accepts radio data that has been collected using Private HERE Venue Maps or custom image-based indoor maps. Note that in case your subscription does not have Private Indoor Positioning feature, the radio data collected using Private HERE Venue Maps or custom image-based indoor maps cannot be published to production.
- In the evaluation phase the Private Radiomap accepts all the radio data regardless of the type of the indoor map used in the data collection. In the evaluation phase you cannot contribute data to the Community Radiomap. However, the HERE Mobile SDK can access both the Private Radiomap and Community Radiomap so that you can get the complete understanding of the system behaviour.

Business Features

HERE Indoor Positioning supports two business features and their combination:

- *Private Indoor Positioning feature*

  With this feature, you have access to all the tools (HERE Mobile SDK, HERE Indoor Radio Mapper). You can contribute data to the Draft Radiomap and Private Radiomap, and use the Private Radiomap in your application.

- *Public Indoor Positioning feature*

  With this plan, you have access to all the tools (HERE Mobile SDK, HERE Indoor Radio Mapper). You can contribute data to the Draft Radiomap and the Community Radiomap, and use the Community Radiomap in your application.

- *Both features enabled*

  In case your subscription has both features enabled, you can contribute data to the Private Radiomap and Community Radiomap (depending upon the indoor map you use). You can also control whether you want to use Private Radiomap or the Community Radiomap in your application through the HERE SDK. See the *HERE Android SDK Developer's Guide Premium Edition* or *HERE iOS SDK Developer's Guide Premium Edition for details.*

Note that in the evaluation phase both features are enabled in your subscription, but you can only contribute data to the Draft Radiomap and Private Radiomap. However, you can use both Private Radiomap and Community Radiomap in your application (see above).

Evaluation Versus Commercial Use

Once you decide to engage commercially with HERE, your SDK License Key is updated and you may receive new Application ID and Application Code.

There may also be some impact on your radio data in our system. Please see *Data Flows and Business Features* on page 34 for further information.

Data Flows and Business Features

This section details the data flows within HERE Indoor Positioning. There are several factors affecting the data flows:

- Your business features
- Radiomap type (Draft, Private and Community) – access to the production radiomaps depends on your business features
- Type of the indoor map used in data collection

The following tables outline the radio data flows depending on the business features, indoor map type and commercial status.

Table 8: Data flows for the Evaluation phase

	Draft Radiomap	Private Radiomap	Community Radiomap
Data contribution options (the indoor map types allowed in radio data collection)	Supported options: • public Venue Map • private Venue Map • image-based indoor map	Supported options: • public Venue Map • private Venue Map • image-based indoor map	Not supported
SDK Access (radiomap types the SDK can access)	Not supported	Default access	Optional access (see the SDK developer guide)

Note: Upon publishing any radio data goes to the Private Radiomap irrespective of the type of the indoor map used in data collection.

Table 9: Data flows for the Private Indoor Positioning feature

	Draft Radiomap	Private Radiomap	Community Radiomap
Data contribution options (the indoor map types allowed in radio data collection)	Supported options: • public Venue Map • private Venue Map • image-based indoor map	Supported options: • private Venue Map • image-based indoor map	Not supported
SDK Access (radiomap types the SDK can access)	Not supported	Access	Not supported

Note: Upon publishing radio data collected using the private indoor maps (Private HERE Venue Maps or custom image-based indoor maps) goes to the Private Radiomap. Data collected using Public HERE Venue Maps stays unpublished.

Note: Upon change from evalution to commercial phase with only Private Indoor Positioning feature, the published radio data collected using Public HERE Venue Maps gets unpublished.

Table 10: Data flows for the Public Indoor Positioning feature

	Draft Radiomap	Private Radiomap	Community Radiomap
Data contribution options (the indoor map types allowed to in radio data collection)	Supported options: • public Venue Map • private Venue Map • image-based indoor map	Not supported	Supported options: • public Venue Map
SDK Access (radiomap types the SDK can access)	Not supported	Not supported	Access

Note: Upon publishing the radio data collected using the Public HERE Venue Maps goes to the Community Radiomap. Data collected using Private HERE Venue Maps or custom image-based indoor maps stays unpublished.

Note: Upon change from evalution to commercial phase with only Public Indoor Positioning feature, there will be the following changes.

- any published data is withdrawn from the Private Radiomap, i.e. in practical terms the Private Radiomap gets cleared
- any published radio data that was collected using Public Venue Maps is re-published to the Community Radiomap

Table 11: Data flows for the Public+Private Indoor Positioning features

	Draft Radiomap	Private Radiomap	Community Radiomap
Data contribution options (the indoor map types allowed to in radio data collection)	Supported options: • public Venue Map • private Venue Map • image-based indoor map	Supported options: • private Venue Map • image-based indoor map	Supported options: • public Venue Map
SDK Access (radiomap types the SDK can access)	Not supported	Default access	Optional access (see the SDK developer guide)

Note: Upon publishing radio data collected using Private HERE Venue Maps or custom image-based indoor map goes to the Private Radiomap, and the radio data collected using Public Venue Maps goes to the Community Radiomap.

Note: Upon change from evalution to commercial phase with Private+Public Indoor Positioning feature, any published radio data that was collected using Public Venue Maps is re-published to the Community Radiomap and withdrawn from the Private Radiomap.

Change of the Business Features

The following table shows the radio data behavior when you change from one set of business features to another set.

Table 12: Change in the business features impacts to your data

Old feature set	New featureset	Changes
Private	Public	Private Radiomap shall be cleared, but the radio data is kept intact
Public	Private	You lose control over the data you have published to Community Radiomap. Your Private Radiomap will be empty initially.
Private + Public	Private	You lose control over the data you have published to Community Radiomap. Your Private Radiomap is unchanged.
Private + Public	Public	Private Radiomap shall be cleared, but the radio data is kept intact

Chapter 7

FAQ

Topics:

The sections below contain frequently asked questions, grouped by category, reflecting issues users may have when setting up HERE Indoor Positioning.

Frequently Asked Questions on Beacons

Why does HERE recommend the use of Eddystone beacons?

The Eddystone standard defines a telemetry message that can be used to monitor the beacon health status without any proprietary techniques.

Can I use my own beacons?

Yes you can, but you should follow our general guidelines about the beacons including power saving, transmit powers, and transmit intervals. For example, beacons deployed for advertisement purposes typically have low transmit power and potentially also a low transmit interval. Both factors make beacons with such a configuration unsuitable for positioning. If you are unsure about the suitability of your beacon deployment for positioning purposes, you can contact HERE Technical Support.

Frequently Asked Questions on Deployment

Can I move a beacon that is already installed to a new location?

Currently it is not possible to move a beacon to a new location. Do not relocate or recycle beacons.

Can I remove a beacon that is already installed?

Yes you can, but make sure that the recommended beacon density remains.

How should I handle beacons that have been removed?

Always remove batteries from the beacon that has been removed or take the beacon to a storage away from the deployment area. Do not relocate or recycle beacons.

Is it possible to re-plan an existing beacon installation?

Re-planning requires some additional operations. The previously collected radio data needs to be deleted and new radio data collection needs to be performed after the beacons are redeployed.

What happens if the beacon deployment does not follow the recommended grid size?

A smaller grid size may only have a negligible positive impact on the quality of positioning. A larger grid size degrades positioning quality.

Which way should I orient the beacon?

Typically, most beacon antennas are omnidirectional, especially the ones that we recommend. In this case the orientation does not have an impact on the performance. However, in case beacons have directional antennas, the beam direction should be set so that it covers the intended area.

Can I deploy incrementally for a building, or do I need to do it all at once?

We recommend that you deploy across the whole building at once. This is because the radio signals penetrate quite well through the walls and ceilings. Thus any new deployment may disrupt the positioning service in the areas with earlier sub-deployments.

Can I deploy for only a part of the building?

It is possible, but some special considerations need to be taken into account, such as making sure to collect radio data in all the areas in which the beacon signals can be observed. This means collecting radio data over quite a large area around the actual beacon deployment. You may also have to visit parts of the floors above/below the beacon deployment.

Can I mix different beacon types in one deployment?

Yes it is possible, but not recommended. This may cause some difficulty for maintenance work, because of the different battery types and battery lifetimes, and so on. Also, it is highly recommended that all the beacons have the same HERE recommended configuration.

What should I do if a beacon is constantly falling off from the wall?

Because of different types of wall surface, sometimes a beacon might not stick. Try a different tape or glue and check the surface purity. If the surface is really problematic, you may need to mount the beacon with scews. In addition, using cable ties is one reliable option for fastening beacons.

Is it enough to deploy beacons just inside the building?

There is no need to deploy beacons outside a building to make the positioning work inside a building. However, if you wish to use positioning outside as well, with a smooth transition from indoor to outdoor (and vice versa), it is worth considering deploying beacons outside. Or, at least indoors close to the outer wall or windows. This ensures that the signal penetrates well outside of the building. In

this case, you should also remember to perform radio data collection outside of the building. See HERE Indoor Radio Mapper User Guide for further details on collecting radio data outdoors.

How can I prevent malicious people from reconfiguring my beacons?

The HERE recommended beacon configuration does not allow any connections to the beacon thus making remote reconfiguration impossible.

Frequently Asked Questions on Radio Data Collection

What are the recommended devices for the radio data collection?

HERE recommends to use Acer Iconia One 10 B3-A20B 32GB WiFi edition for the radio data collection.

When is new radio data collection required?

New radio data collection is necessary, typically, if a large number of radio nodes (WiFi access points or Bluetooth beacons) have been removed from a venue or if there is an observable degradation in positioning performance.

Addition of new radio nodes does not compromise positioning performance. HERE Indoor Positioning can observe new nodes, but because they are not in the included radiomap, they are not used in positioning.

However, if you decide to perform radio data collection after adding a new radio node, ensure that you visit carefully the whole area covered by the new node. Also, you need to collect radio data in floors above and below in case the building structure allows radio signals to penetrate from one floor to another.

Removing a small number of radio nodes from a venue typically has a negligible effect on positioning performance. However, performance degradation is likely if a significant number of nodes are removed, especially locally. Therefore, if you need to remove radio nodes, it is best to install new ones in their place.

Noticeable degradation in positioning performance is a clear sign that new radio data collection is required. This can be caused by the removal of radio nodes within the venue or significant changes to the floor layout and/or repositioning of existing nodes. If such changes are extensive or if multiple changes affecting a small number of nodes have occurred over time, it is best to delete the old radio data and collect new radio data with the HERE Indoor Radio Mapper.

Can I use partial radio data collection to enable positioning in a small area?

You can do this, but it is not advisable if the users of the positioning service can access the floor above and/or the floor below the area of interest. Radio signals typically penetrate from one floor to another and thus, when a user passes above or below the area, his/her device can observe the signals from the area of interest. There is a high likelihood of incorrectly locating the user on the wrong floor. To avoid such errors, it is best to collect radio data for the same area in the floor above and the floor below the area that was the primary target for positioning and, thus, radio data collection.

For example, if you collect radio data in a small area on floor 5, cover approximately the same area on floors 4 and 6 as well. Note, however, that this approach leaves open the possibility that a person moving on floor 3 below the collected area is likely to be positioned to floor 4. The best guarantee of correct indoor positioning is to collec radio data from the whole venue. However, if the venue has a single floor or the users can only access one floor, then partial radio data collection is sufficient.

If you opt for partial data collection, please collect in a larger area than the part of the building where you require optimum positioning performance. Bear in mind, that devices observe radio nodes from the radiomap some meters outside the collected area, both before they enter that area and after they leave it. This may cause some transient issues, when moving from an area, where radio data has been collected, to an unvisited area.

To geofence in a small area, do I need to collect radio data in the whole venue?

Not necessarily. Please see the discussion of *partial radio collection*, because similar considerations apply in geofencing. This includes the likelihood that partial data collection may produce good results, when users have access to only one floor.

Should I also collect radio data outside of the building?

If, in your use case, it is important that the positioning technology changes smoothly from indoor methods to outdoor methods (cellular, WiFi, or GNSS), then it is advisable to collect radio data outside of your building. Refer to the HERE Indoor Radio Mapper User Guide for instructions on how to change the collection method between indoor and outdoor radio data collection.

Frequently Asked Questions on Positioning

What factors affect HERE Indoor Positioning performance?

HERE Indoor Positioning performance (accuracy) is a sum of many factors, including:

- The radio environment (density of radio nodes, variability of the signal strength field)

- Devices used in data collection (some devices have better scan quality)
- Device used for positioning (some devices have better scan quality)
- Building geometry (some buildings are more challenging e.g. for floor detection)

It is hard to quantify the impact of each of these to the observed performance. HERE Indoor Positioning algorithms are designed to mitigate the effects of the varying device characteristics.

When it comes to the radio environment, the best performance is typically achieved when five to ten Bluetooth beacons are observable in each scan, assuming that the beacon deployment is optimized for positioning rather than, for example, for advertising purposes. Similarly, when WiFi is used, it is desirable to have roughly ten true physical WiFi access points in each scan. Very often, the WiFi access points in modern deployments are MIMO access points, which means that a single physical access point acts as multiple logical ones. Such logical access points do not significantly contribute to the positioning performance.

Where is the position estimate calculated?

The position estimate is calculated in the device itself. The HERE Mobile SDK only accesses the network to download the new or updated radiomap after which device can be used in the offline mode. All the required computations take place in the device resulting in less latency and better accuracy than network-based solutions. The added benefit of this approach is user privacy, because no location information is sent from the device to the cloud.

How do you handle positioning technology changes?

The algorithms inside the HERE Mobile SDK handle the positioning technology changes automatically. The set of the location technologies available to the HERE Mobile SDK depends on:

- Your SDK license
- Device capabilities
- Operating System settings (for example whether WiFi and/or Bluetooth are enabled)
- Positioning mode set via the API (indoor-only or hybrid)
- Operating System itself (in iOS we can only support Bluetooth-based indoor positioning)

What happens if a device moves from indoors to outdoors or vice versa?

The HERE Mobile SDK algorithms detect whether and when a device moves from an indoor space outdoors and switch from indoor positioning technology to, for example, GNSS. Similarly, when a device enters an indoor space, the switch to indoor positioning occurs automatically and seamlessly.

Frequently Asked Questions on Indoor Maps

Why does HERE recommend the use of HERE Venue Maps instead of my own custom image-based maps?

HERE strongly recommends the use of HERE Venue Maps with HERE Indoor Positioning, for the following reasons:

- HERE Venue Maps are encoded using global latitude and longitude. We guarantee their correctness and, therefore, alignment with the HERE outdoor maps and the coordinates used by HERE indoor and outdoor positioning tecnologies.
- With HERE Venue Maps you save the hassle with aligning the floor plan images with the Latitude-Longitude coordinate system.
- HERE Venue Map floor indexing is standard and static.
- The coordinates remain the same for very long periods of time. If you need to collect radio data at a site again after a few years, the original device or the coordinates used for the alignment may no longer be available to you. This can cause mismatches between the original and new alignments, leading to performance degradation.

However, in recognition that there are valid commercial use cases for custom image-based indoor maps, HERE Indoor Positioning supports their use in the Draft Radiomap and Private Radiomap, but note that radio data collected using image-based indoor maps cannot be contributed to the Community Radiomap.

Frequently Asked Questions on HERE Account

What happens to my data when my HERE Account is closed or my Indoor Positioning subscription ends?

If you delete your HERE Account, we will delete all your *private* data. However, HERE keeps any radio data you have collected using Public HERE Venue Maps.

If your HERE Indoor Positioning subscription ends, we will keep your data in storage for six (6) months. After this period, HERE will act as in the case of HERE Account deletion (see above).