Indoor Positioning

Installation Guide

Version 2.1

Important Information
Notices

Topics:

This section contains document notices.

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Contents

Chapter 1
Introduction

Topics:

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

- Getting the installation pre-requisites right
- The steps and the workflow, when deploying the HERE Indoor Positioning system
- Configuration and the installation of the Bluetooth beacons
- Important technical information about the HERE Indoor Positioning

HERE Indoor Positioning highlights

HERE Indoor Positioning service features are:

- High accuracy indoor positioning with floor and building detection
- Uses existing Wi-Fi infrastructure and/or standard Bluetooth (Eddystone, iBeacon) beacons
- Accuracy better than 5 meters 50% of the time and >80% floor detection rate in a typical case
- Easy-to-use tools (HERE Indoor Radio Mapper) to collect the radio data at the venue and to manage the radio data
- Radio data can be kept private or exposed publicly to the 3rd party developers
- Integrates seamlessly to other HERE services including HERE cell/Wi-Fi network positioning, HERE Maps, HERE Venue Maps as well as indoor and outdoor routing
- HERE Mobile SDKs for Android and iOS for application developers to access the location information indoors and outdoors
- Works in the offline mode meaning that no internet connection is required after the positioning data has been downloaded to the device to be positioned
- The position is resolved in the device preserving the user privacy

Chapter 2
Quick start

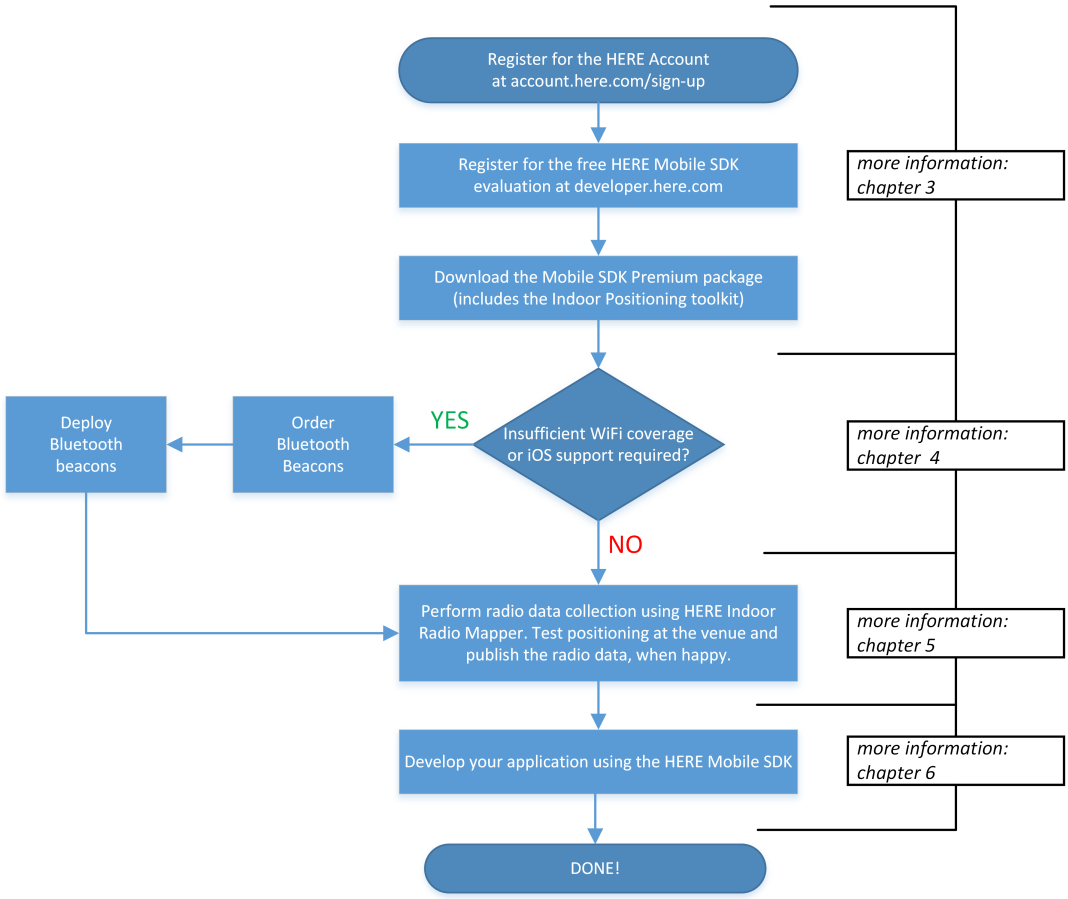
Topics:

This chapter describes, how to get HERE Indoor Positioning functional in the most straighforward manner.

Quick start workflow

The following figure shows the most typical workflow for making HERE Indoor Positioning functional. Detailed information can be found in the referred chapters.

Figure 1: Quick start workflow



In practice, the deployment of the HERE Indoor Positioning consists of four simple steps:

1. Get the HERE Mobile SDK Premium for iOS and/or Android and request for the HERE Indoor Positioning features to be enabled for your evaluation/commercial license from your HERE representative
2. Decide, whether you can use existing Wi-Fi or Bluetooth deployment, or if you need to deploy Bluetooth beacons at your site
3. Collect radio data at the site using the HERE Indoor Radio Mapper (an Android-based tool). The radio data collection allows us to create a map of the radio signal behaviour at the site, which understanding is then used, when estimating the device location. This signal strength map is called a *radiomap*.
4. Develop your application using the HERE Mobile SDK Premium for iOS and/or Android

Chapter 3
HERE Indoor Positioning Prerequisites

Topics:

This chapter guides you through the first steps in setting up the HERE Indoor Positioning.

Indoor Positioning requirements

In order to gain access to the HERE Indoor Positioning tools, documentation and the HERE Mobile SDK, please do the following:

- Create a HERE Account for yourself or your company. You can do this at *account.here.com/sign-up*. The HERE Account is used throughout the HERE services to identify you and your data in the HERE Cloud.
- Access the *HERE Developer Portal* and sign-up for the 90-day free evaluation for HERE Mobile SDK Premium for Android and/or iOS depending upon your needs.
- The sign-up provides you an access to the following resources:
  - HERE Mobile SDK Premium for Android and/or iOS
  - `Application ID`, `Application Code` and the `SDK License key`, which are needed, when you develop an application using the HERE Mobile SDK.
  - HERE Mobile SDK package includes the HERE Indoor Positioning toolkit that consists of:
    - HERE Indoor Radio Mapper application for Android
    - HERE Indoor Positioning Installation Guide (this document)
    - HERE Indoor Radio Mapper User Guide
    - HERE Indoor Radio Mapper Release Notes
- After the above steps, the HERE Indoor Positioning needs to be enabled for your `AppID` by HERE. In order to gain access to the HERE Indoor Positioning features, please provide your HERE representative the `AppID` you obtained earlier. In addition, an Evaluation Agreement may be needed.
- Once you receive a confirmation from your HERE representative that the HERE Indoor Positioning features are now available for you, please retrieve the updated `SDK License key` from the *HERE Developer Portal*.
- After these steps, you are good to use both HERE Indoor Radio Mapper and the HERE Mobile SDK to enable and access indoor positioning at your venue.

Indoor Map requirements

In order to map the radio environment in your venue using HERE Indoor Radio Mapper, you need an access to an indoor map of the venue. The indoor map can be one of the following:

- **HERE Public Venue Map**. The HERE Public Venue Maps are readily available in the HERE Indoor Radio Mapper tool, when you have the HERE Indoor Positioning evaluation or HERE Public Indoor Positioning license.
- **HERE Private Venue Map**. These Venue Maps are made on a customer request. Please contact your HERE representative to have a HERE Private Venue Map done for your venue, and to have it available for your HERE Account. After this, the HERE Private Venue Map will be available for your use in HERE Indoor Radio Mapper and also through the HERE Mobile SDK for the application development.
- **Your own image-based indoor map**. In this case you use an image that describes a floor in the building. The image needs to be available in some commonly used image format such as .jpg, .gif or .png.

  Before the image-based floor plan can be used, HERE Indoor Positioning needs to know, where in the World the building is. This process is called the *alignment* of the indoor map image to the geographical coordinates. The alignment is done in HERE Indoor Radio Mapper by inserting, scaling and rotating the

indoor map image on the HERE map or satellite image. Alternatively, you can input WGS-84 Latitude and Longitude coordinates in decimal format for two points in the image.

Completing the alignment enables seamless switching of positioning technologies between indoor and outdoor. Please refer to the HERE Indoor Radio Mapper User Guide for further details on using your own indoor maps during the radio data collection process.

Chapter 4
Preparing the Radio Environment

Topics:

This section provides the information on setting up the Wi-Fi and/or Bluetooth radio environment at the venue. In case you need to deploy Bluetooth beacons, this section provides guidelines for the Bluetooth beacon configuration and deployment

Wi-Fi or Bluetooth?

You can use either Wi-Fi or Bluetooth beacons to support HERE Indoor Positioning. The use of Bluetooth beacons is mandatory in case iOS support is required, because Wi-Fi cannot be used in the iOS devices. Also note that typically Bluetooth beacons can provide better performance simply because Bluetooth beacons are specifically installed for positioning purposes quite densely. The Wi-Fi network coverage may have gaps and as the deployment is optimized for connectivity, and not for positioning, the positioning performance may vary quite a lot at different parts of the building. Moreover, Wi-Fi network is subject to changes depending upon the connectivity needs, whereas specifically-installed Bluetooth beacon deployment can be assumed to be static. Note that whenever the radio environment changes significantly (e.g. due to Wi-Fi Access Points being moved from one place to another), the radio data must be collected again.

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 or at least in the areas, where you want HERE Indoor Positioning to provide high quality location information. 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.

Sometimes you may want to use an existing Bluetooth beacon deployment to support HERE Indoor Positioning. In this case, please familiarize yourself with the HERE beacon deployment guidelines in this chapter in order to be able to evaluate, if the existing deployment is compatible with HERE Indoor Positioning. Especially, if your venue has an existing Bluetooth deployment for advertising purposes, extra care needs to be taken. Beacons in such deployments maybe transmitting at low power and they maybe moved from one place to another frequently. Both characteristics make such deployments unsuitable for HERE Indoor Positioning.

If you plan to use an existing WiFi or Bluetooth deployment to support HERE Indoor Positioning, you can proceed to the section *Working at the site*. However, if you plan to order and/or deploy Bluetooth beacons, the rest of the chapter discusses the beacon configuration and installation.

Deployment Planning

Beacon deployment requires proper planning prior to installation. Good planning can save a lot of time at the site. 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 examplary 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: Exemplary 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 the beacon 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 surface, 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, i.e. 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 HERE Indoor Positioning 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 HERE Indoor Positioning.

Beacon Configuration

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 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
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 can have multiple Namespaces for different purposes, e.g. there could be one namespace for beacons used for positioning purposes and other namespace for beacons used for advertisement purposes.

The Namespace can be derived from the company website URL with a suitable hashing algorithm, and if necessary, cropping the resulting hash. For example, HERE uses in its Eddystones the Namespace that is 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, HERE uses in its iBeacons the UUID that is 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. For example, a single Major ID can be assigned for beacons used for positioning purposes in a single venue and another Major ID for beacons used for advertisement purposes at the same venue.

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	Details
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
Minew Technologies, China *http://minew.en.alibaba.com/*	product name "i3"	2 AA batteries (2000-3000 mAh, 5 years lifetime(1)) IP65 dust-tight, water resistant

(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 (UUID, Major ID and Minor ID for iBeacons) definitions
- Whether you require pre-installed batteries and a sealed case

Chapter 5
Working at the Site

Topics:

This chapter summarizes the steps you need to perform at the venue for which HERE Indoor Positioning is to be deployed. At this time it is assumed that the radio environment at the venue has been prepared as specified in the previous chapter.

Collecting Radio Data at Your Site

HERE Indoor Radio Mapper is an Android application that is used to collect the Wifi and/or Bluetooth radio environment at a venue. The HERE Indoor Radio Mapper User Guide describes the radio data collection workflow in detail and thus only a short summary is given below.

When you launch the HERE Indoor Radio Mapper, you need to log in with your HERE Account credentials. Please note that you are not able to log in unless your HERE Account has at least one `AppID` with HERE Indoor Positioning features enabled.

After a successful login, you will be able to access all the HERE Venue Maps you are eligible to use. Firstly, this may include HERE Public Venue Maps assuming that you have HERE Indoor Positioning evaluation or your HERE Indoor Positioning license includes HERE Public Indoor Positioning feature. You are free to collect radio data at any of these 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 HERE Indoor Radio Mapper landing page automatically assuming that you have HERE Indoor Positioning evaluation or your HERE Indoor Positioning license includes HERE Private Indoor Positioning feature.

You can also use your own image-based custom indoor maps, provided you import those images to HERE Indoor Radio Mapper and align those to the geograhical coordinate system. The alignment is needed for HERE Indoor Positioning to know, where in the World the building is to enable seamless switching of positioning technologies between indoor and outdoor. Refer to the HERE Indoor Radio Mapper User Guide for further details on the importing and alignment process.

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

1. Displaying the appropriate indoor map (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 indoor 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 and contain information, at each location, on the WiFi Access Points and/or Bluetooth beacons and their signal strengths.

The above process must be repeated in each part of the building in which you want to set up HERE Indoor Positioning. The time required to collect the radio 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 same 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.

Figure 3: Radio data for one WiFi Access Point collected with HERE Indoor Radio Mapper

When you are ready with the radio data collection, the radio data gets automatically uploaded to the HERE Cloud for further processing and analysis. The result of this analysis is an understanding of how the radio signals behave in the building. This understanding is called a *radiomap* for the venue.

Testing Positioning at the Site

You can test out HERE Indoor Positioning just a few minutes after the collected radio data has been uploaded to the HERE Cloud. HERE Indoor Radio Mapper will notify you once the data has been processed and testing can commence. Upon entering the Test view in HERE Indoor Radio Mapper, you can walk around the building and you can see HERE Indoor Positioning in action on an indoor map (either HERE Venue Map or your own custom indoor map). 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. Again, please refer to the HERE Indoor Radio Mapper User Guide for detailed information regarding the testing features.

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 users. Please refer to the HERE Indoor Radio Mapper User Guide for further details on publishing.

Chapter 6
Working with the HERE Mobile SDK

Topics:

This section discusses accessing the indoor location information through HERE Mobile SDK.

Using HERE Mobile SDK and Indoor Positioning

HERE Mobile SDK offers a rich set of APIs including positioning, maps and routing. All of these features work both indoors and outdoors. Navigation instructions are, however, only available outdoors at this time.

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

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

- High accuracy indoor positioning with building and floor detection using Wi-Fi and Bluetooth radios
- Cellular network positioning in GSM, CDMA, WCDMA, TD-SCDMA and LTE networks as well as global crowd-sourced Wi-Fi network positioning
- Positioning without network connectivity through the download of radiomaps from the HERE Cloud. As soon as 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 the vicinity of a 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. The selection is automatic between WiFi and Bluetooth radiomaps (if both are available) as well as between indoor and outdoor positioning methods, if enabled in your HERE Mobile SDK license.
- HERE Indoor Positioning supports both private and public data. In case your venue is a private one (HERE Private Venue Map or your own custom indoor map), indoor location information is only available for your applications (identified by `AppIDs`). In contrast, indoor location information for public venues (HERE Public Venue Maps) is available for all the HERE Mobile SDK users with an appropriate license.
- Global positioning coverage and data hosting infrastructure for the optimal availability, reliability and user experience

The Positioning API provides access to the following position-related information:

- Location (latitude and longitude)
- Estimated location uncertainty in meters as the CEP68 value
- Speed and heading
- 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 need to set the building name when importing the custom venue to the HERE Indoor Radio Mapper. The building ID is generated automatically from the set name.
- Information on the used positioning technology (Bluetooth, WiFi, cell, GNSS)

For detailed descriptions on the Positioning and other APIs, see the *HERE Android SDK Developer's Guide Premium Edition* or *HERE iOS SDK Developer's Guide Premium Edition* for details.

Testing the HERE Mobile SDKs

The HERE Mobile SDK package includes an example application for both Android and iOS to test the HERE Indoor Positioning (and other positioning methods, too) quickly. It is assumed that the radio data has been collected at the venue as instructed and that the radio data has been published in HERE Indoor Radio Mapper for use by HERE Mobile SDK. Only then can indoor location information be accessed through HERE Mobile SDK.

Smoke test application (Android)

The HERE Mobile SDK Premium for Android includes example code in the `BasicPositioningSolution` tutorial to get your first HERE Indoor Positioning application up and running smoothly. 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"

The HERE Mobile SDK indoor positioning smoke test is successful, if these details are visible.

Smoke test application (iOS)

Setup the `HEREPositioningTutorial` application located in the sample-apps folder within the HERE Mobile SDK Premium 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 7
Technical Information

Topics:

This section provides technical information on the data flows in the HERE Indoor Positioning system. An important concept of radiomaps is discussed thoroughly: a radiomap is the description of the radio signal strength landscape in a venue and is generated based on the radio data collected with the HERE Indoor Radio Mapper. The radiomaps and their usage are related to the available business features and indoor map types.

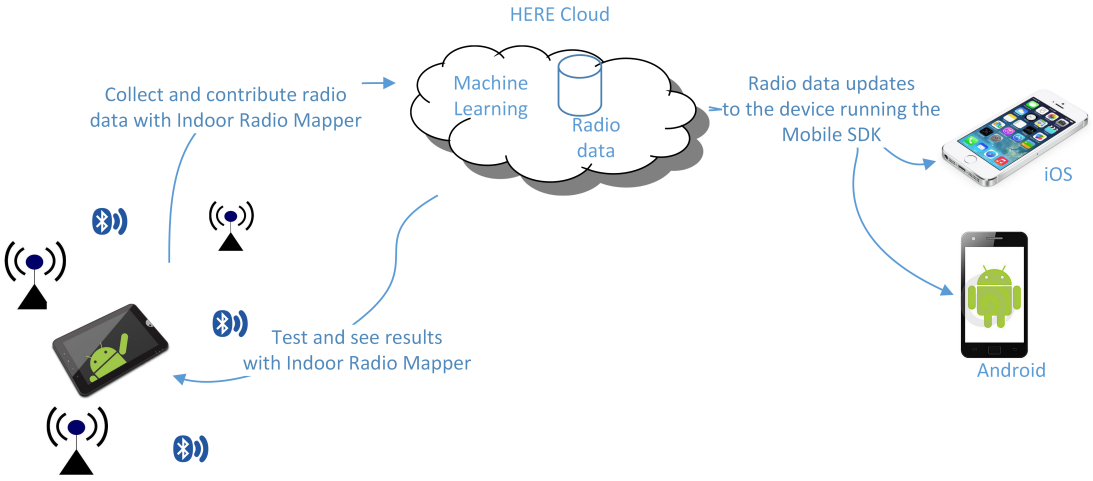
The Very High Level view

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 access indoor positioning information

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

Figure 4: High level data flow in HERE Indoor Positioning



Radiomaps in HERE Indoor Positioning

A radiomap is the description of the radio signal strength landscape in a venue and is generated based on the radio data collected with the HERE Indoor Radio Mapper. There are three types of radiomaps in HERE Indoor Positioning system:

- *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 HERE Indoor Radio Mapper is initially included only in the Draft Radiomap when uploaded. Moreover, 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 (either Private or Community Radiomap) 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 in HERE Indoor Radio Mapper without affecting the positioning data utilized by the HERE Mobile SDK users until you decide to publish new radio data.

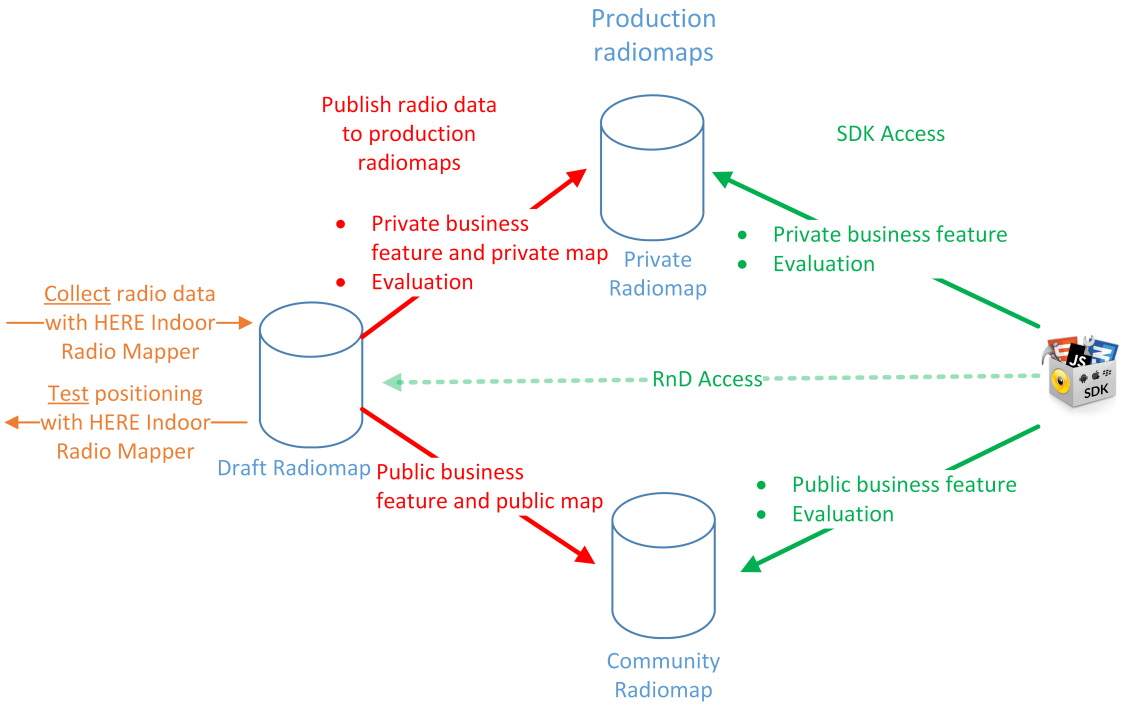
The HERE Mobile SDK accesses the production radiomap(s). The production radiomap(s) in use depend on the Business Features enabled in your subscription (see *Business Features*).

Important: The HERE Mobile SDK can also be configured to access the Draft Radiomap in the development phase. Please see the SDK Developer Guide for details.

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 5: Data flow high level view



The important concepts of the radio data flow are:

- The Draft Radiomap is intended for testing. It allows HERE Indoor Positioning operators and developers to run trials on the system with no impact on the positioning performance for the end users that use production radiomaps via HERE Mobile SDK. The Draft Radiomap is account-specific, which means it is private to the account owner.

  When the radio data is collected with HERE Indoor Radio Mapper and uploaded to the HERE Cloud, the radio data is automatically assigned to the Draft Radiomap. Moreover, when testing positioning with the HERE Indoor Radio Mapper, the tool always uses 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 HERE Indoor Positioning to these applications, the Draft Radiomap needs to be published using the HERE Indoor Radio Mapper. At the publish, the Draft Radiomap gets synchronized to the production radiomap(s).
- 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 `AppIDs` associated with your HERE Account. The Private Radiomap cannot be accessed by the other customers.
- Once the radio data is being published, the production radiomap to which the radio data goes to is controlled by your license 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 HERE Public Venue Maps, and only when you have an active HERE Public Indoor Positioning feature included in your license.
  - The Private Radiomap only accepts radio data that has been collected using HERE Private Venue Maps or your own custom image-based indoor maps, and only when you have an active HERE Private Indoor Positioning feature included in your license.
- In the evaluation phase the Private Radiomap accepts all the radio data regardless of the type of the indoor map used in the radio 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 a complete understanding of the system behaviour.
- The HERE Mobile SDK can be configured to access the Draft Radiomap for testing and development purposes for a limited number of devices. See HERE Mobile SDK Developer Guide for details.

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 radio data to the Draft Radiomap and Private Radiomap, and use the Private Radiomap in your application.
- *Public Indoor Positioning feature*

  With this feature you have access to all the tools (HERE Mobile SDK, HERE Indoor Radio Mapper). You can contribute radio data to the Draft Radiomap and the Community Radiomap, and use the Community Radiomap in your application.
- *Both features enabled*

  In case your license has both features enabled, you can contribute radio 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 Mobile 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 license, but you can only contribute radio data to the Draft Radiomap and Private Radiomap. However, you can use both Private Radiomap and Community Radiomap in your application (see above).

Note: Regardless of the business features in your HERE Mobile SDK license, the Draft Radiomap is at your disposal for development purposes in HERE Mobile SDK for Android. See the *HERE Android SDK Developer's Guide Premium Edition*.

Evaluation Versus Commercial Use

Once you decide to engage commercially with HERE, your `SDK License Key` is updated and you may receive a new `AppID` and `AppCode`.

There may also be some impact on your radio data in the HERE Indoor Positioning system. Please see *Data Flows and Business Features* on page 33 for further information.

Data Flows and Business Features

This section details the data flows within the HERE Indoor Positioning system. 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 the radio data collection

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

Table 5: 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)	Optional access (Android-only, see the SDK developer guide)	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 6: 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: • 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)	Optional access (Android-only, see the SDK developer guide)	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.

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

Table 7: 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 • image-based indoor map	Not supported	Supported options: • public Venue Map
SDK Access (radiomap types the SDK can access)	Optional access (Android-only, see the SDK developer guide)	Not supported	Access

Note: Upon publishing the radio data collected using the HERE Public Venue Maps goes to the Community Radiomap. Radio data collected using custom image-based indoor maps cannot be published.

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

- Any radio data collected using HERE Private Venue Maps will be lost
- Private Radiomap gets cleared and cannot be accessed by the HERE Mobile SDK
- Any published radio data that was collected using HERE Public Venue Maps is re-published to the Community Radiomap
- Radio data collected using the custom image-based indoor maps stays in the Draft Radiomap and can be accessed by the HERE Mobile SDK for Android in the RnD mode

Table 8: 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)	Optional access (Android-only, see the SDK developer guide)	Default access	Optional access (see the SDK developer guide)

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

Note: Upon change from the evalution to the commercial phase with Private+Public HERE Indoor Positioning features, any published radio data that was collected using HERE 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 9: Impacts to your data, when changing the business features

Old feature set	New feature set	Changes
Private	Public	Radio data collected for HERE Private Venue will be lost. Private Radiomap shall be cleared and the radio data collected for custom image-based indoor maps will only be available in the Draft radiomap.
Public	Private	You lose control of the radio data you have published to the Community Radiomap. Your Private Radiomap will be empty initially.
Private + Public	Private	You lose control of the radio data you have published to the Community Radiomap. Your Private Radiomap is unchanged.
Private + Public	Public	Radio data collected for HERE Private Venue will be lost. Private Radiomap shall be cleared and the radio data collected for custom image-based indoor maps will only be available in the Draft radiomap.

Chapter 8
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.

Can I use an existing beacon deployment?

Yes you can, given that the existing deployment fulfils the HERE requirements for the beacon density and the beacon installation stability. Especially, if the existing beacon deployment has been installed for the advertisement purposes, extra care needs to be taken as beacons in such a setup are typically moved from one location to another frequently. In such a case the deployment cannot be used to support HERE Indoor Positioning. Moreover, all of the issues discussed in the previous question are valid considerations for this question as well.

If you are unsure about the suitability of your beacon deployment for positioning purposes, you can contact HERE Technical Support.

Frequently Asked Questions on Beacon 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?

Noticeable degradation in positioning performance is a clear sign that new radio data collection is required. However, it is essential to understand the root cause for the degradation. There may be several reasons to this:

- **Structural changes**. If the degradation is due to the structural changes in the building, then deleting the old radio data in HERE Indoor Radio Mapper and collecting new radio data is a must.
- **Radio node re-arrangement**. In case radio nodes are moved around in the building, again deleting the old radio data in HERE Indoor Radio Mapper and collecting new radio data is a must. Note that HERE Indoor Positioning can tolerate some changes, but if a large number of radio nodes is moved around, the radio data must be re-collected.
- **Losing or removing radio nodes**. Losing or 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 is lost or removed, especially locally. Therefore, if you need to remove radio nodes, it is best to install new ones in their place and perform re-collection of the radio data.

The addition of new radio nodes does not compromise positioning performance. HERE Mobile SDK can observe the new nodes, but because they are not included in the radiomap, they are not used in positioning and thus do not affect location estimation. 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.

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, the user 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 the floor 5, cover approximately the same area on the floors 4 and 6 as well. Note, however, that this approach leaves open the possibility that a person moving on the floor 3 below the collected area is likely to be positioned to the floor 4. The best guarantee of correct indoor positioning is to collect 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 the partial radio 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 of 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 the partial radio 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 for the best performance. Now, 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. Again, the set of outdoor positioning technologies at your disposal depends on the same factors as listed above.

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 geographical Latitude and Longitude coordinates. We guarantee the correctness of the coordinates as well as the proper alignment between the HERE outdoor maps and HERE Venue Maps. This further ensures that the coordinate systems used by the HERE outdoor positioning technologies and HERE Indoor Positioning match and the indoor-outdoor transition will work seamlessly.
- 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 your building again after a few years and need to re-align your custom indoor map, there may be a mismatch between the old and new alignment. This may lead to the HERE Indoor Positioning performance degradation. With HERE Venue Maps you do not have this issue.

However, in recognition that there are valid use cases for the use of 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 for 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).