

insoft GmbH

INDOOR POSITIONING & NAVIGATION

A Guide on Technologies and Use Cases



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INTRODUCTION

Dear readers,

infsoft has been offering indoor localization and indoor navigation services for more than ten years now. It all started in 2005, when smartphones didn't exist yet.

So much has happened since that time. I would say, the introduction of the iPhone and the beacon technology were the major mile stones for the industry. But the best is still to come.



The application areas of indoor positioning technology seem to be endless. And there are various techniques which can be used. We want to help you find your way through this complex topic and have thus collected some of our texts which might be interesting for you. You can also find a lot of interesting content in our [indoor navigation wiki](#).

If you have any questions considering those topics, don't hesitate to contact us. We are here to help you.

Please stay connected and let us know what you think, for example via [Facebook](#) and [Twitter](#).

All the best,

A handwritten signature in black ink that reads "T. Donaubauer". The signature is fluid and cursive, with a long horizontal stroke at the end.

Tobias Donaubauer, CEO

1. INDUSTRIES

1.1. LOCATION BASED SERVICES AND INDOOR NAVIGATION IN RAILWAY STATIONS



infsoft's railway station solutions

Modern railway stations must satisfy high requirements: Of course it is extremely important that passengers reach their destination fast and safe. Especially people with reduced mobility may welcome support. The large number of merchants wishes for a good platform to present themselves and the possibility to realize location based advertising. For the station operator a lot of opportunities arise considering facility management.

Advantages for travelers

Particularly on longer journeys with several changeovers, things sometimes don't go as planned. Platform changes or delays don't cause so much stress when the passenger is informed about it as early as possible. Passenger applications for smartphone can offer this via push notifications and real time updated schedules. Because in fact the actual arrival and departure times count – not the estimated ones. Being able to book a ticket whilst travelling and having a precise routing towards the right track maybe saves the passenger some valuable minutes. Routing within the station can take different levels of accessibility into account. It is even possible to implement intermodal door to door navigation including public transport. Passengers arriving by car can be shown the best possible car park – including a transparent overview of parking fees.

If there is any time left in the station, the app helps passengers to quickly find the way to a certain shop or food stall.

Advantages for merchants and restaurants

Merchants can send their potential customers tailored offers – for example picking those who have already been to similar shops or who are returning visitors. And for sure everyone is delighted by a discount of his favorite shop pushed directly on his smartphone.

Advantages for railway station operators

Using infsoft's indoor location analytics, station operators gain a lot of information about visitor flows inside the building. With a clearly arranged web interface they see much frequented areas and can take action if it tends to become overcrowded. Based on these data a lot of further functions can be realized.

1.2. LOCATION BASED SERVICES AND INDOOR NAVIGATION IN AIRPORTS



insoft's airport solutions

When people want to go on holiday by plane most of them are both full of anticipation and tension. Business travelers want to keep the waiting times to a minimum and make good use of it. As an airport operator it is your goal to offer passengers a trouble-free and comfortable stay. Shops and restaurants wish for passengers who have enough free time to consume. All of those needs can be better satisfied by insoft's branch solutions.

Advantages for passengers

People who travel infrequently may need support in complex infrastructures like airports. Starting your holidays relaxed is not so easy when you are confronted with unknown surroundings, tricky routing and foreign languages on your journey. Especially people with reduced mobility may have specific requirements.

This is where the benefits of indoor navigation become apparent. It shows the exact routing from car park or railway station to the terminal. It is even possible to implement intermodal door to door navigation. When passengers cover the distance quickly, there still remains enough time to discover shops or take a break in a restaurant. Merchants can push tailored advertising directly to the smartphone and offer a lot of added value for the customer. For example it could be a coupon or a custom-fit offer. Back from the journey, the airport app helps passengers to find back to their car or public transportation.

Business travelers have all information concerning their flight and their boarding pass in their pocket and can quickly find a place to work and relax.

Advantages for stores and restaurants

Merchants can push custom-fit offers directly to the smartphone of interested clients: For example those who have already visited this or similar shops. And for sure everyone is delighted by a discount of his favorite shop. In addition you learn a lot about visitor flows in or nearby the store. Large shops can also use the technique for asset tracking, for example in order to improve theft protection or logistics.

Advantages for airport operators

The advantages for merchants and passengers listed above improve customer satisfaction. Using Indoor Location Analytics you can even get detailed information about the stream of visitors. These data can be used as a substantial argument when leasing floor space. It can also help your security staff: As soon as somebody enters a restricted area or when certain areas are overcrowded action items can be triggered.

1.3. INDOOR NAVIGATION AND LOCATION BASED SERVICES FOR TRADE FAIRS



insoft's trade fair solutions

Have you ever wandered through an exhibition, studying a heavy catalogue, looking for interesting exhibitors? Or for a cash machine, the wardrobe, the right car park? Perhaps you as an exhibitor had too little or not so interested visitors at your exhibition stand. Or perhaps you are a trade fair organizer who wants to assist exhibitors and visitors to take full advantage of their trade fair participation.

Modern indoor navigation solutions can solve these problems. A cross-channel trade fair solution provides added value to trade show organizers, exhibitors and visitors.

Advantages for trade show organizers

The aim of a trade show organizer is to create an attractive event both for visitors and exhibitors. A trade fair application makes information about exhibitors, services, public transport and framework programme available to visitors. Personalized content matches the right visitors and exhibitors. With insoft's Location Analytics you can analyze visitor flows. During and after the event you can get precise information about hot spots and the number of people in a certain hall or at a stand. The tool also gives you advice on how to optimize routes, for example when they are overcrowded.

Exhibitors can sponsor the app and thereby co-finance it.

Advantages for exhibitors

Of course exhibitors have the possibility to present themselves on the map of the area in the trade fair app, including pictures, contact data and description. Furthermore, they can use location based marketing in order to get the attention of the matching visitors. The analysis of visitor flows makes it possible to choose the best stand position.

Advantages for trade fair visitors

Indoor positioning in exhibition halls helps visitors to find the way to certain stands. The app can be personalized, which means that exactly those stands can be highlighted on a map which are interesting for a visitor. Intermodal transport is also possible: Let the app show you the way from your home to the stand you want to see – you can even see arrival and departure times of environmentally friendly public transportation.

1.4. INDOOR NAVIGATION AND LOCATION BASED SERVICES FOR SHOPPING CENTERS



infsoft's mall solutions

Going to a mall is a great experience. There is a large and immediately available selection of goods, very good advice and always a nice café or restaurant to take a break. In summary, shopping in a mall is great fun. It is in the interest of shops and operators that customers discover new and relevant stores and restaurants.

infsoft solutions can offer operators, shops and customers real value added. A good mall navigation app improves the shopping experience and increases revenues. Location analytics provide reliable data concerning visitor flows in the building.

Advantages for customers in shopping centers

Shopping center apps improve shopping experience. Its functionality is not limited to display the latest offers and a list of shops and points of interest. It can also guide customers there – if you wish even with means of augmented reality. Additionally, it can recommend offers that might be interesting for them – based on previous stays or purchases.

Advantages for mall operators

For mall operators it is important to know your customers are happy – because happy clients will stay in the mall for longer and visit more stores and restaurants. A mall navigation app with indoor positioning can help them have a better shopping experience – with the help of routing or location based marketing. For example, a customer who is near a clothing store can be sent an offer or a coupon to his smartphone. This kind of information is customized and offers him individual added value instead of annoying him with unsuitable advertising.

Using indoor location analytics mall operators can measure and analyze visitor flows easily. And the security department can also take advantage: They can be sent a message when people enter restricted areas or when certain sectors are overcrowded. Privacy and data protection are taken care of. Shop owners can sponsor the app and thereby co-finance it.

Advantages for shop owners

Shop owners can easily learn a lot about their clients: How many visitors are near my store at a certain time, how many enter it? How do they move inside? Additionally they can do precisely targeted location based marketing: For example purchasing incentives can be sent on the smartphones of a selected group.

1.5. MOBILE SHOPPING SOLUTIONS AT AIRPORTS AND RAILWAY STATIONS – TWO USE CASES FROM OUR CLIENTS



Digitalization is a major topic for stationary trading at the moment. There are constantly new developments and trends in this field. If city centers and shopping malls cross your mind when thinking about retail, you might not be wrong. But you forget about some big players: Meanwhile, airports and railway stations are among the largest shopping centers.

One example is Frankfurt Airport which is the largest shopping mall in Germany with its 230 public shops and service facilities. Another one is Zurich main railway station which provides about 180 shops, pharmacies and service companies. Fraport AG and SBB (Swiss Federal Railways) consequently rely on connected mobile services and digitalization in retail. insoft supports both companies with mobile solutions.

Comprehensive multichannel strategy at Frankfurt Airport

Frankfurt Airport, the largest airport in Germany, recently received an award at a US-e-commerce conference for the shopping features of its app which is based on maps by insoft. The jury liked the comprehensive approach which brings together information, orientation, service and shopping and at the same time involves different communication and sales channels such as web store, app and stationary trading.

The digital map and the positioning technology of insoft make it possible to orientate oneself via app, info terminal or PC and to navigate to individual shops. When the user enters his flight number, he receives real time information about waiting time and plan changes. The additional time can for example be used for shopping. [Read the Fraport app success story](#)

The app has an integrated online shop based on the Magento platform. Travelers can reserve products whilst travelling and pick it up at the shop when they arrive in Frankfurt. It is planned to deliver the products to the gate or to the client's home and to enable online payment. Clients receive rewards for all purchases which can be redeemed at the airport.

SBB "My Station" app enables shopping on the move

insoft has developed an app for SBB (Swiss Federal Railways) which helps passengers to find one's way in Switzerland's largest railway station, Zurich central station. 1200 beacons help locate users in an interactive map which also offers indoor navigation. Besides other features, SBB focuses on shopping possibilities. [Read the SBB success story and try an interactive demo of the app.](#)

SBB's "SpeedyShop" is integrated into the app. Customers can order grocery, cosmetics and more whilst travelling and pick it up 30 minutes later or when arriving in Zurich. This feature is very useful for commuters and people who are in a hurry. The app also offers changing discount coupons and special offers which can be redeemed at the station. Of course there is a list of all shops including detailed information. You can pick one shop and navigate there.

Summary

Travellers in particular profit from mobile shopping solutions. They can make good use of the additional time and when they arrive, everything is already done. Of course it is necessary to adapt the channel to mobile use. Additionally it is an advantage if the shopping function is complemented by other features of the app. For example, the customer could be shown current waiting times or receive recommendations based on his interests or use indoor navigation. The operators can profit a lot, for example through participation in sales. infssoft's indoor tracking technology also makes it possible to measure visitor flows and analyze itineraries. On the basis of these data higher rents can be claimed.

1.6. INDOOR NAVIGATION AND LOCATION BASED SERVICES FOR OFFICE AND INDUSTRY



Indoor positioning in office buildings and industry areas

Indoor positioning and indoor navigation can make the management of large offices and industry buildings a lot easier and employees can also benefit from it. For example, you can track assets or people, support the security service and offer your staff an employee app.

Benefits from asset- and staff tracking

Assumed that your company site includes a large warehouse, you can determine the location of pallets or vehicles by the means of indoor positioning with an accuracy of less than a meter. The position can be displayed for example in an app or web based platform. It also works with very high storage depots with several levels. It is possible to automatically send a message to the security service when goods leave a defined area. These functions can also be applied to staff and external companies. Both can be integrated in an operation control system, in order to delegate tasks.

Advantages for employees

An employee app facilitates work and social contacts for the staff working in large buildings. For example, the application can show them the way to offices and meeting rooms – you can even directly book them. By means of the buddy finder colleagues can exchange their positions and meet up for lunch or an appointment. Further useful and time-saving information which can be included are opening hours and dishes offered by the canteen, departure times of public transport and the position of the employee's car.

1.7. BEACONS AND POSITIONING TECHNOLOGY IN TOURISM



Positioning technology for tourism

The tourism industry has to find new ways to acquire customers, to bind them and to increase margins. There is high competitive pressure and price transparency – holiday destinations seem to be interchangeable. Mobile apps connected with positioning technologies are one possibility to stand out from competitors, increase additional sales, occupy new niches and bind customers.

Use cases for indoor positioning in tourism

Railway

Railway operators already give their customers useful information about the train schedule, booking tickets and delays via app. Intermodal navigation becomes more and more important. For travelers it will be possible to plan their complete journey from door to door, using different means of transportation. Indoor navigation in large train stations and individual suggestions concerning shopping, eating and drinking are another trend. Have a look at the use case SBB (Swiss Federal Railways).

Airport

For airports there are similar rules as for railway stations. It is especially important to provide some good service during the journey: passengers get a message when their flight is delayed, when the gate changes, when there are waiting times at the check in or when boarding starts. Frankfurt Airport offers indoor navigation and retail applications, for example an online shop with click & collect, in its app. Have a look at the use case Frankfurt Airport.

Hotel

Hotels want to adapt to the needs of the “Generation-Y” and business travelers who are “always on” and expect personal service – digital components are welcome. Receptionists can surprise guests if they know about their preferences before arrival – for example they can offer them their favorite drink at the check in. The personal data can be transmitted digitally which makes it redundant to fill in forms. Systems working with beacon technology can trigger the check in process automatically when the guest arrives. He can also receive a welcome message and special additional offers. Have a look at the hotel app conichi.

Holiday destinations

Holiday destinations have to face the challenge to stand out from competitors by focusing on individual key topics. Apps that have access to the preferences of visitors (for example via Facebook API or manual selection) can make relevant offers throughout the whole customer journey which make the holidays unforgettable. This could be for example hiking tour suggestions for families when the guest comes with children. Beacons which are spread across the destination can detect his position and trigger the transmission of location specific information about sights and events. It is also a kind gesture to send out a welcome message when people enter the tourist information.





















Museums

Apps for museum visitors can show additional information and interactive content about exhibits which are nearby. Indoor navigation can also be beneficial in large museum buildings.

The applications which are described here do not only have chances but also risks. Users are not so willing to install standalone apps anymore. Apps which sum up multiple services have better chances. The app has to have a concrete added value which is easy to see. Data protection should be considered. The staff on-site should be well-informed about the application. Push messages have to be used economically and must not be like spam. When the application should be able to show motion profiles and heat maps and a back channel to the user is required, you need an app.

2. POSITIONING TECHNOLOGIES

2.1. TECHNIQUES FOR CLIENT BASED INDOOR POSITIONING – GPS, WIFI, BLUETOOTH AND VLC COMPARED

Technology	Indoor/Outdoor	Accuracy	Range	Cross-Platform	Power Supply
GPS		 5-20 m	 worldwide		
WiFi		 5-15 m	 < 150 m		
Bluetooth		 1-3 m	 < 30 m		
VLC		 < 50 cm	 < 8 m		

Indoor positioning technologies compared: pros and cons

We will introduce various techniques for indoor positioning to you now.

[GPS for indoor positioning](#)

[WiFi for indoor positioning](#)

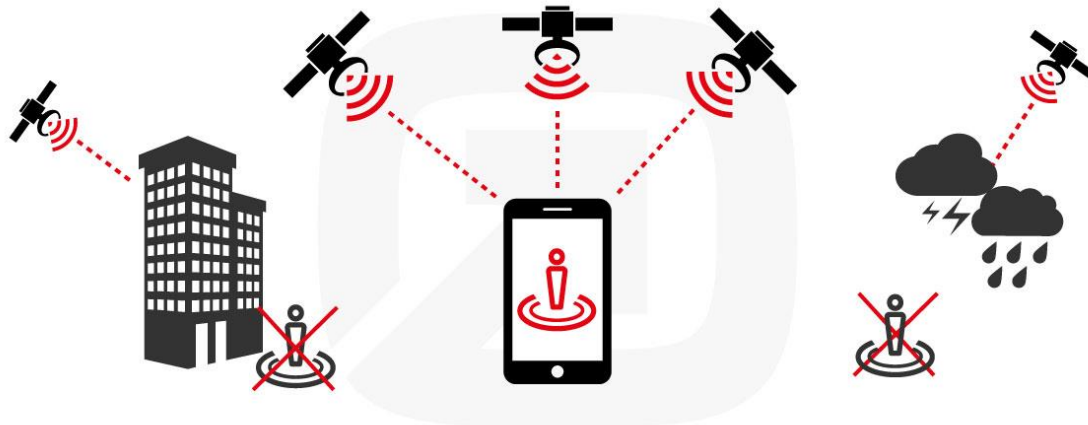
[Bluetooth for indoor positioning](#)

[VLC \(visible light communication\) for indoor positioning](#)

Infographic: pros & cons of indoor positioning techniques

Each one of these technologies has its pros and cons and in many cases they can complement each other. We have summarized GPS, WiFi, Bluetooth/Beacons and VLC with an infographic in order to make them better comparable. If you like the infographic, please don't hesitate to show it to your colleagues or share it on Facebook, Twitter etc.

2.2. TECHNIQUES FOR INDOOR POSITIONING WITHOUT USING GPS



GPS reception can be impaired inside and outside buildings

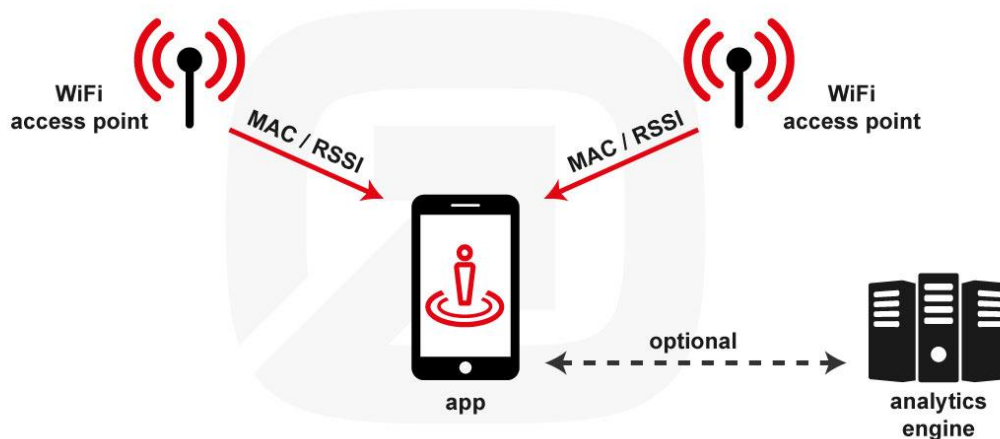
Positioning and navigation using smartphones are very beneficial in everyday life. Where would we be without the friendly voice of google maps which shows us the way wherever we are? But, wait a moment, everywhere is not quite correct. GPS reception quickly reaches its limits, for example in tunnels, parking garages, under a cloud cover, in the forest, in urban canyons, inside buildings – in brief: GPS driven navigation does not work where there is no visual contact to several GPS satellites. And there is another problem: With GPS it is not possible to determine the floor level a device is located on. But there are some possibilities to put such an “indoor GPS” into practice.

Indoor navigation and indoor positioning realized without gps

Navigation is necessary after you entered a building, too. In complex facilities with several floors such as airports, exhibition halls, railway stations, hospitals, shopping malls, office and industry buildings and many more accurate navigation like we know it from road traffic navigation is desirable. Regarding asset tracking, staff tracking, location based services and geofencing, an accurate location determination is essential.

Indoor positioning and indoor navigation are therefore a big issue in many industries.

2.3. INDOOR NAVIGATION USING WIFI AS A POSITIONING TECHNOLOGY



WiFi can be used for indoor positioning

Inside buildings WiFi is a good alternative to GPS, which is not available indoors. In most cases it is easy to install a WiFi positioning system (WPS), since WiFi access points already exist in many buildings. The advantage is that for example existing cash register systems, public hotspots and access points of shops or exhibitors can be used. The user doesn't necessarily have to connect with the WiFi, it is sufficient to have WiFi enabled.

For positioning, the so-called fingerprinting method is used. The strength of the WiFi signals (received signal strength indication, RSSI) and the MAC address (media access control) are significant. There must be an appropriate app installed on the smartphone which calculates the current position based on these data. Later in this article you will learn about how these data are collected.

Accuracy of wifi for indoor positioning

Accuracy depends on multiple factors, for example the number of available networks, reflections for example in corridors and last but not least shielding through walls, ceilings and your own body. The accuracy of WiFi used for indoor positioning varies from five to 15 meters – depending on the preconditions. Sensor fusion – this means the use of smartphone sensors – can even improve accuracy. A big advantage compared to GPS is that it is possible to determine the current floor level.

Setting up an indoor positioning system using wifi

The calibration of position determination works with a one-time reference measurement in the run-up, where the signal strength of the WiFi networks is determined. For this purpose insoft offers an app with which the client can easily execute the measurement on his own. This solution is client based, which means an app is necessary. Check out our [developer portal](#) and the SDK for more information and videos.

If a server based solution is more suitable for the project, insoft's self-developed locator nodes can be used. In this case no app is required, all WiFi capable devices are detected and WiFi tracking (asset tracking of, for example, mobile goods) is possible. Locator nodes also support Bluetooth low energy.

Pros and cons of indoor positioning using wifi

Pros:

- indoor positioning works without GPS
- existing WiFi infrastructure can be used
- enabled WiFi is sufficient
- there is a back channel to the client
- large range (up to 150m)
- detects floor level

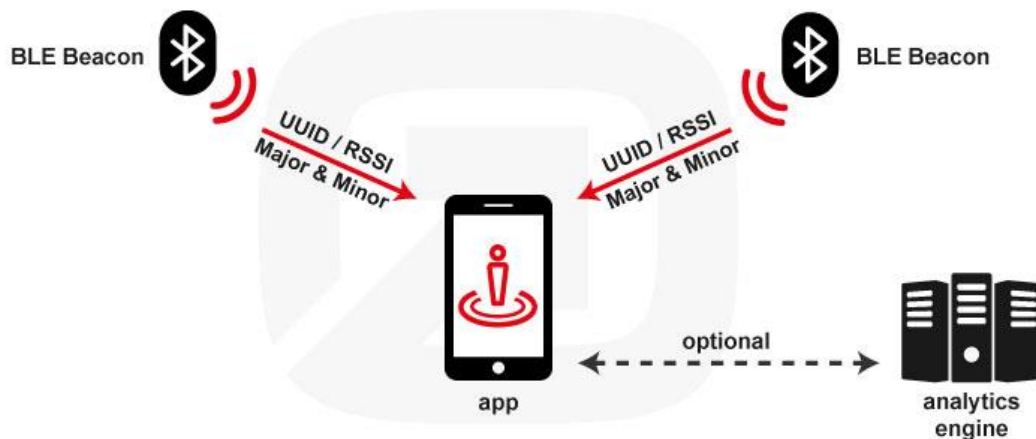
Cons:

- relatively inaccurate (5-15m) compared to BLE/RFID
- WiFi client based positioning is not possible with iOS devices – but BLE can be used as an alternative
- application required

Application areas of an indoor positioning system using wifi

Indoor navigation using WiFi makes sense when WiFi has to replace GPS in buildings. For example in complex infrastructures such as shopping malls, exhibition halls, railway stations, airports, hospitals, museums, office and industry buildings. An indoor navigation app improves visitor service and enables analyzing visitor flows.

2.4. INDOOR NAVIGATION & INDOOR POSITIONING USING BLUETOOTH



Indoor navigation and indoor positioning using Bluetooth

During the last couple of years, there was a lot going on on the Bluetooth market. The technology itself is not new; the functionality of Bluetooth has been well-known since the 1990s. But it was only in recent years that whole new application scenarios have occurred, originating from the energy saving Bluetooth version BLE (Bluetooth Low Energy, Bluetooth Smart). Apple with its iBeacons and just recently Google with its Eddystone Beacons have got the market moving furthermore.

Indoor navigation using bluetooth

Since GPS does not work indoors, Bluetooth is a good alternative for indoor positioning and indoor navigation. Bluetooth beacons are able to send out signals, but they can't receive them. They are relatively cheap, can run on button cells up to two years and have a maximum range of 30 meters indoors. Accuracy is up to one meter. On the one hand they are used in client based solutions, that is to say, positioning via app on the smartphone itself. In this case, Bluetooth must be activated on the device. On the other hand, server based tracking solutions using beacons are possible as well.

For positioning in client based applications, several beacons are required. They send out unique signals with which the app determines the position by means of fingerprinting. Based on beacons, it is possible to trigger an action, for example displaying a coupon or information on the smartphone.

Application areas of beacon indoor navigation

Currently, Bluetooth beacons are mostly applied in stationary trading. They connect the online and offline world and are supposed to increase sales at the point of sale (POS), for example by means of coupons or advertisements. Also, navigation in complex buildings and detailed information about exhibits in museums and at trade fairs are much asked for.

It is also possible to analyze visitor flows. Based on that information, products in shops can be arranged perfectly or walking routes can be optimized. The technical possibilities offer a lot of opportunities to provide the customer, visitor, patient, employee or traveler relevant information at the right time and at the right place.

Installation of indoor positioning via bluetooth

Calibrating the position determination is as easy as when using WiFi. infsoft provides a calibration app, by which clients can work independently. infsoft also offers a beacon management tool to monitor battery levels and set up business logics to replace batches in certain areas.

infsoft does not provide beacon hardware, but we are happy to establish contacts of beacon suppliers.

Pros and cons of indoor positioning using beacons

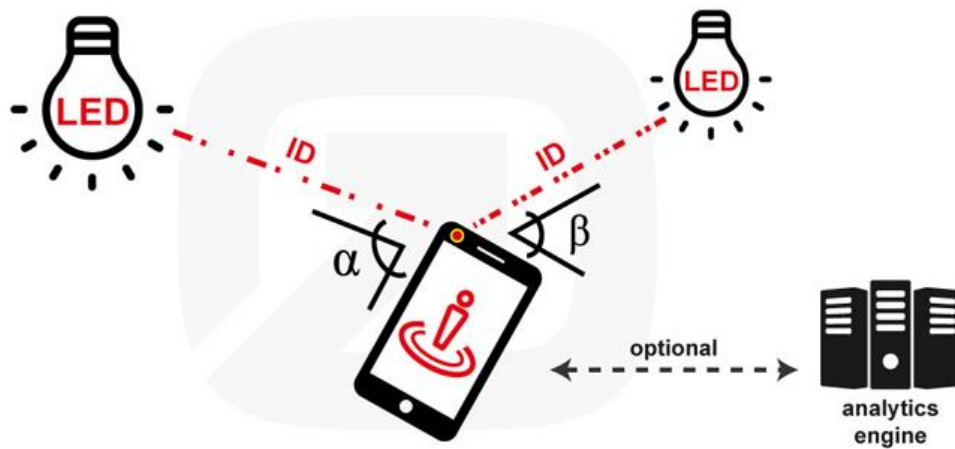
Pros:

- cost-effective, unremarkable hardware
- low energy consumption
- flexible integration into the existing infrastructure (battery-powered or power supply via lamps and the domestic electrical system)
- works where other positioning techniques do not have a signal
- compatible with iOS and Android
- high accuracy compared to WiFi (up to 1m)

Cons:

- additional hardware
- app is required for client based solutions
- relatively small range (up to 30m)

2.5. INDOOR NAVIGATION, INDOOR POSITIONING AND LOCATION BASED SERVICES USING VLC (VISIBLE LIGHT COMMUNICATION)



VLC can be an alternative positioning method inside buildings

In the recent blog posts we have already introduced the most common methods for indoor positioning: WiFi and Bluetooth. Both are already being used in various scenarios and have proved to be successful. VLC (visible light communication) is a new, interesting method which is about to reach market maturity.

Visible light communication – what is it capable of?

VLC can be used as a positioning technology, mainly for inside areas. Special LED and fluorescent lamps send out indiscernibly flickering light which can be detected by a smartphone camera or a separate photo detector, which is for example attached to a shopping basket. This enables for example indoor navigation (via app) and tracking (analysis of motion profiles via app). In the future, VLC could also be used for wireless internet connection.

Technically it works like that: Each lamp has its own ID which it compiles into pulsing light and sends to smartphones in the reception range. The app can access a map in which the lamps and their IDs are located. The incidence angle helps refine the position. Additional hardware such as beacons can fill in, where light doesn't advance.

Application areas for VLC

VLC is suitable for all industries and use cases in which beacons are used. For example: supermarkets, shopping malls, DIY stores, airports, railway stations, hotels, gastronomy, parking garages, the health care sector, museums, trade fairs, office buildings and industry areas. A smartphone can determine its position via VLC (client based) – therefore and for having a back channel, an app is necessary. Thus, notifications (for example coupons) can be transmitted to the user. Server based tracking, which includes devices without app, only works with additional hardware in the lamp.

Specific use cases could be: Passengers can easily find their car in an airport parking garage with the help of an app and VLC. Customers of supermarkets are being navigated to the required products as the crow flies.

Pros & cons of visible light communication

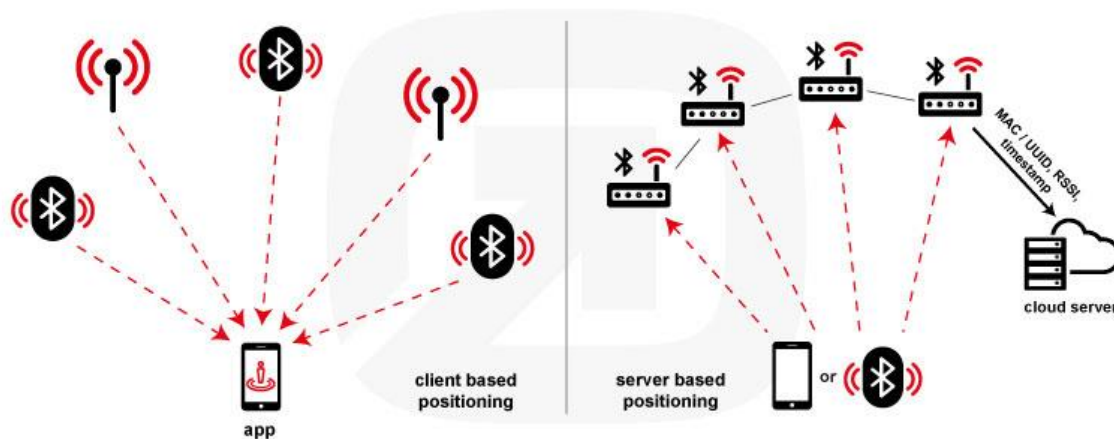
Pros:

- lamps are extensively and homogenously available in buildings
- beacons can complement positioning
- signals can easily be limited
- modern LED are energy efficient
- the positioning technology is not dependent on batteries
- VLC is precise (less than 1 meter) and has a high range (up to 8 meters)
- no disturbing, eye-catching, costly hardware
- works cross-platform

Cons:

- draws on the reserves of the smartphone battery
- low flexibility when installing lamps
- most suitable for indoor installations
- high costs when modern lamps are already installed
- back channel and tracking only possible with special hardware/app

2.6. CLIENT BASED AND SERVER BASED INDOOR POSITIONING



Client based/server based positioning: What are the differences and which method is suitable for which application scenario?

Client based indoor positioning

When using client based positioning, positioning is done directly on the device. There must be an adequate app installed which analyzes the signals of WiFi access points, LED and/or beacons. The app contains a database with which the signal strength is matched. This way, the device can detect its position via fingerprinting without being connected to an access point. The location owner can send the visitor messages – for example location based ads and useful information. Client based positioning means that the user's data don't leave the phone as long as it's only about positioning.

Client based positioning is mainly suitable for indoor navigation in retail, at trade fairs, airports, railway stations and in museums and hospitals. It is of big advantage that existing WiFi access points can be used. Projects focusing exclusively on WiFi will exclude all Apple devices because they cannot determine their position via WiFi.

Server based indoor positioning

Server based positioning means that a WiFi enabled device, a tag or a Bluetooth beacon sends out a unique key (MAC address, UUID). Specific hardware captures the signals and transmits them to a server which calculates the position via fingerprinting based on signal strengths and coordinates.

Server based positioning detects all devices, an app is not required. This method is especially suitable for asset and personnel tracking. For example, it is possible to detect the position of medical instruments at a clinic, vehicles in industrial facilities and goods in retail. Geofencing enables automatic notifications when object leave a defined area (theft protection). Location owners can profit from information about visitor flows. Employers can detect the current position of their employees, for example at a large exhibition stand. In most cases, tracking is done anonymously.

2.7. INDOOR TRACKING OF PEOPLE AND OBJECTS – THIS IS HOW IT WORKS



Indoor location tracking of people and goods

Indoor location tracking and indoor positioning of people and objects are getting more relevant for companies from various industries. There are two ways to realize it: client based and server based tracking. Learn more about the differences and which method is suitable for your use case.

Functionality of indoor location tracking

Client based tracking means that the position of a person is detected on a mobile device (mostly a smartphone). An app calculates the position based on beacons or WiFi access points distributed in the room – the latter doesn't work with iOS devices.

When applying server based tracking, the people and objects you want to track are equipped with a Beacon (BLE) or a smartphone. This transmitter sends out its ID via Bluetooth Low Energy to small receivers which are distributed in the room. insoft develops so-called "Locator Nodes". They only have to be connected to the power supply and one of them needs internet connection. The detected IDs and field strengths are transmitted to a cloud server where they are converted into geographic coordinates. A user friendly web interface displays the devices in a digital map. It is also possible to process the data with other insoft systems, for example in order to create anonymized motion profiles or heat maps.

[Learn more about client based and server based indoor positioning and our indoor tracking solutions.](#)

Use cases for indoor tracking

Client based tracking is good if you want a back channel over which you can send coupons or information. The requirement is that all people who should be tracked have an up-to-date smartphone.

Server based tracking is perfect for asset tracking. For example if you want to determine the position of goods and equipment. Geofencing can be used for theft protection. For server based tracking of people smartphone and app are not necessary. A discreet and cheap beacon in the jacket pocket combined with locator nodes is enough for positioning. Beacons can also help to find people inside a building in case of emergency. To make sure employees always have the receiver with them, it can be integrated into an ISO card.

2.8. THE ROLE OF HARDWARE IN INDOOR POSITIONING PROJECTS



Indoor positioning and indoor navigation are strongly marked by software products: For example in order to create a digital map, to calibrate routes, to evaluate results and to give users access via app. But as soon as it comes to choosing the suitable positioning technology, hardware plays an important role.

Using beacons for indoor positioning

Bluetooth beacons are the most frequently used method for indoor positioning. When Apple introduced the iBeacon standard, they started to boom and related formats such as Google's Eddystone are becoming more and more popular because of their interesting features. The advantages are obvious: They are extremely flexible because they run on batteries and are affordable. Thus, temporary installations can be put into practice without any problems. The energy consumption of beacons is low, thanks to the modern Bluetooth Low Energy (BLE) standard. Battery runtime is rising constantly. Beacon management platforms make it easy to maintain the infrastructure. Accuracy is between 1 and 3 meters which is more than enough for most use cases. Additionally, beacons work cross-platform in client based settings - using WiFi as a positioning technology excludes all Apple devices.

infsoft has installed a typical client based solution at Zurich main railway station. Travelers profit from turn-by-turn navigation and a lot of useful information and offerings via app. [Have a look at the use case.](#)

Server based solutions also work with beacons. For example they make it possible to find people and objects in large industry buildings (personnel tracking/evacuation), the analysis of itineraries, applications in the security sector (access control, theft protection, dead man's handle) and workplace management. For those server based solutions an additional hardware component is necessary – [infsoft Locator Nodes](#).

infsoft Locator Nodes – server based tracking of people, objects and animals

infsoft Locator Nodes are small, electrically-powered devices (for example based on Raspberry Pi), on which we install a firmware by infsoft. They can detect all devices, WiFi tags and beacons (stickers, wristbands etc.) and track them server based. In addition to positioning, the technology also allows for the analysis of visitor flows within buildings. Positioning accuracy is under 5 meters. infsoft Locator Nodes are connected to the electrical grid. They connect with each other so that only one of the devices needs access to the internet (via Ethernet, WiFi or UMTS). This kind of hardware is especially interesting for industrial areas. If you need support with your project, [don't hesitate to contact us](#).

2.9. ASSET TRACKING AND ANALYTICS: HARDWARE FOR INDOOR TRACKING



Indoor Tracking, that is locating persons and objects inside buildings, is in high demand. There are multiple application scenarios.

- Locating wares during the whole production process
- Tracking of working equipment and vehicles
- Position determination of employees/patients and runway analysis
- Leading clients to specific products with indoor navigation
- Theft protection and other security applications, for example evacuation
- Giving drivers turn-by-turn directions

infsoft Locator Nodes: individual application scenarios

infsoft Locator Nodes are a piece of hardware which we have especially developed for the needs of our clients. They can capture all mobile devices (i.e. smartphones), WiFi enabled devices (i.e. WiFi tags) and Bluetooth beacons (attached to people/goods) and track them server based, without requiring an app. The small receivers are distributed throughout the building and connected to the electrical grid. One of them has internet connection. The Locator Nodes collect the data they receive from a sender (usually smartphone or beacon) and transmit them to a cloud server, where the data is processed. With the multiple tools from infsoft, it is for example possible to look at the position and to analyze movement patterns – in public space they are anonymous. infsoft Locator Nodes also work as beacons.



infsoft Locator Tags: the flexible tracking solution

infsoft Locator Tags are perfect for large areas with relatively few objects or people to be tracked, for example when medical equipment should be tracked in a clinic. Locator Tags are small and relatively cheap WiFi and BLE transmitters which can be attached to people or objects. In order to determine their position, Bluetooth beacons are distributed all over the building. Beacons are cheap (3-30 Euros) and can simply be stuck to the walls. The Locator Tags receive the beacon signals and transmit the data to a server where the position is calculated. The beacons can additionally be used for precise indoor navigation for clients and employees.

infsoft Ultra-wideband (UWB): for high precision

Indoor positioning with Ultra-wideband is relevant for certain tracking solutions in the industry environment where a high precision of 10-30 cm and low latencies are required. The installation can be server based (Visualization of positioning data in the backend, no display on a client (smartphone)) or client based Visualization of positioning data on a client (smartphone) and if necessary transmission to the backend). In order to track vehicles, wares and people precisely, you will need UWB Anchors and one infsoft Locator Tag, respectively one additional infsoft Locator Node for server based installations.

2.10. INDOOR TRACKING USING BEACONS OR RFID – WHAT ARE THE DIFFERENCES?

	 Beacon	 RFID
Possibilities	Extensive tracking – server based and client based	Selective object identification
Range	Up to 30 meters inside buildings	Passive: up to 4 meters Active: up to 100 meters
Accuracy	Server based tracking: below 5 meters	Tending to be more accurate, but depends on type of RFID tag. No extensive positioning.
Cost	About 9€ each, plus hardware (insoft Locator Nodes) and software if necessary	Readers are rather expensive, passive RFID tags are cheap
Durability	A few days up to 8 years running on batteries, can be connected to the electrical grid	Passive tags: long durability

Frequently, clients or prospective customers ask us which tracking hardware we would recommend: beacons or RFID. As always, it depends on the requirements and circumstances on site. However, in most cases the decision is pro beacons, because RFID is not suitable for extensive positioning but rather for selective object identification.

Advantages and disadvantages of beacons and RFID in tracking projects

RFID tags need a reader on every point where the position has to be determined. Since readers are relatively expensive, it is not possible to install them across the whole area. Thus, it is only possible to determine the position at a few points (for example: “The object has passed hall no. 10”). Whereas, when an object or person is equipped with a beacon, the position can be determined in real time. You can even see the whole itinerary. Beacons work with Bluetooth Low Energy which can be received by all modern smartphones, unlike RFID.

With beacons, it is possible to do client based and server based positioning. Client based means that position determination happens on the device (smartphone). For this, an app is required which messages can be sent to (back channel). Server based positioning means that Bluetooth beacons send signals which are detected by hardware (insoft Locator Nodes) and passed on to a server. An app is not necessary.

RFID does not allow automatic positioning or navigation. A typical use case is tracking wares in a large storehouse. There are some pre-defined points with RFID readers which an object passes by. The reader identifies the object and receives the information “Ware XY has passed checkpoint 5”.

When using beacons and Locator Nodes, it is possible to get the current position in real time and with an accuracy of less than 5 meters. In addition, you see the whole itinerary of the object.

In summary, it can be said that beacons are a technology which is more flexible and more powerful. But in some simple use cases, RFID tags can be a favorable alternative.

2.11. INDOOR NAVIGATION WITH BEACONS – HOW TO USE THEM IN THE MOST INTELLIGENT WAY



Indoor navigation using beacons - frequently asked questions. Photo: estimote/infsoft

Indoor navigation using beacons is suitable for many purposes and has a lot of advantages. Many of our customers work with beacons. But there are always some frequently asked questions and uncertainties. In this article we would like to answer some questions concerning range, accuracy, application scenarios and battery life and show you different types of beacons. Furthermore, we tell you more about “Beacon Alive”, infsoft’s beacon management platform for large spaces.

Range, accuracy, application scenarios and battery life of beacons

Bluetooth Low Energy (Bluetooth LE, Bluetooth Smart, BLE) is an energy saving radio technology which has become popular since 2009. The range is about 10-30 meters inside buildings; the accuracy is up to one meter. Bluetooth can be used indoors and outdoors with server or client based applications and works cross-platform.

Usually, beacons run on batteries which have to be replaced after a maximum of 5-10 years – depending on the transmission interval and –strength. Some beacons can be connected to the domestic electrical system or lamps and get their energy here. Beacons with an integrated motion sensor can switch themselves off for energy saving when the object they are attached to doesn’t move for a specific time.

Beacons are easy to install (stick, screw) and thus are perfect for exceptional and temporary environments. They cost about 3-30 Euros. Beacons are available with various cases fulfilling diverse IP protection classes. For example they could be suitable for outdoor usage, waterproof and dust-proof.

Types of beacons – Eddystone and iBeacon

The most important beacon types on the market are from Apple (iBeacon) and Google (Eddystone).

iBeacons have been introduced in 2013 and have caused a boom in beacon technology. They transmit a unique ID which can be received and interpreted by mobile apps on all devices which support BLE. By the means of fingerprinting and trilateration the position of a device in a room can be detected and indoor navigation can be realized. iBeacons are very popular. They need an external database or an app to be used meaningfully.

Eddystone has been put on the market by Google in 2015 and can be used open source. They can transmit a unique ID, a URL and sensor data. Smartphones don’t need a special app to receive the URL – which creates whole new opportunities for proximity marketing. Sensor data about humidity, noise, air pollution and temperature can for example be used to send a notification if the temperature exceeds a certain value.

Advantages of a beacon management platform

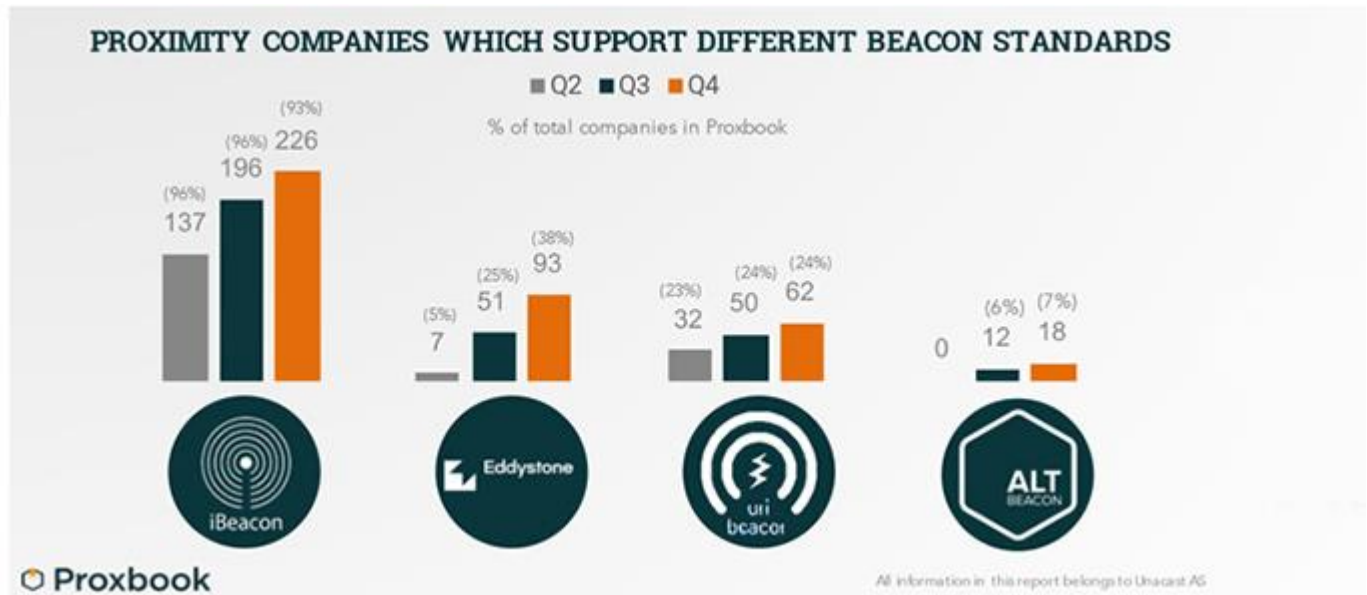
A beacon management platform can help maintain a large area equipped with beacons. Our client SBB (Swiss Federal Railways) uses “Beacon Alive”, which is integrated into infsoft’s Calibration Tools, to manage approximately 1,200 beacons at Zurich central railway station. For example it is possible to check the battery status of the beacons and to send a notification if it falls below a certain value. The management platform also shows in a map when a beacon was last seen. This simplifies the replacement of broken hardware significantly. It is also possible to locate beacons through the platform automatically, which makes it easier to install the beacons. Parameter setting (transmission interval, -duration and –strength) works with most beacon types.

If you want to have a closer look on our backend tools, [register at our developer portal](#).

infsoft doesn’t sell beacons, but we are happy to advise you and establish contact to distributors.

2.12. HOW TO CONFIGURE AND INSTALL BEACONS CORRECTLY

By now, there are 4 beacon standards: iBeacon by Apple, Eddystone by Google, UriBeacon and Altbeacon. iBeacons still constitute the main part, but Eddystone constantly gains market share because of its interesting features. In this blog post we answer the question how iBeacons can be configured and how to install all kinds of beacons in the best possible way at a location.



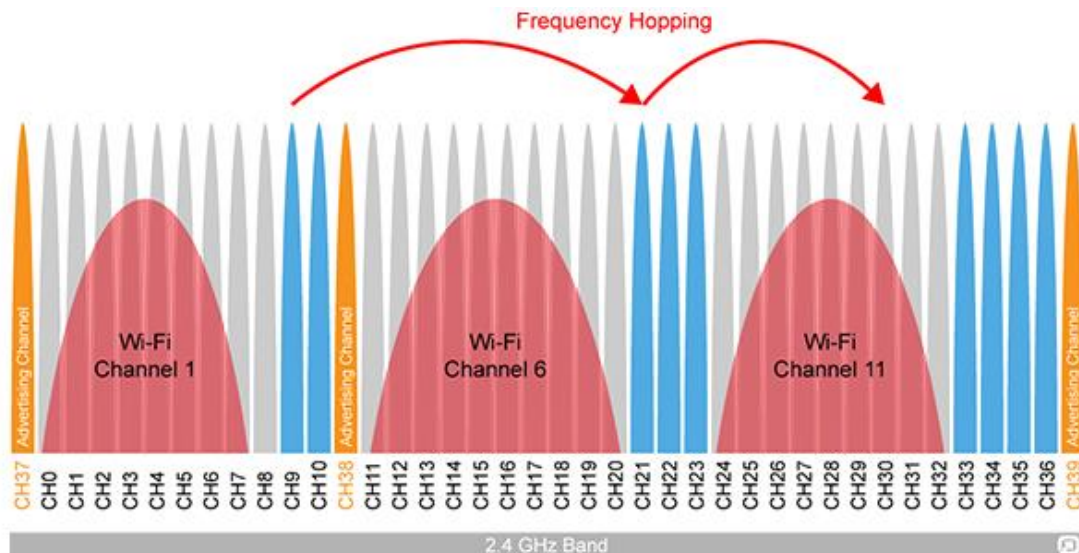
Proxbook report on beacon usage (THE PROXBOOK REPORT - THE STATE OF THE PROXIMITY INDUSTRY Q4 2015 18.01.2016, p. 10)

1. Shielding

Beacon signals can be shielded by multiple materials, for example walls out of wood, concrete or metal. This has also to be considered when installing beacons on pillars in the room. The best place for beacons is between 2,5 - 4 meters high – otherwise people could shield the signals. Favorable positions are on walls and on beams hanging from the ceiling. It can also be a good alternative to install beacons inside lamps since they are evenly spread across the building and can supply the beacon with electricity. The most important thing is to avoid interfering objects between the transmitters.

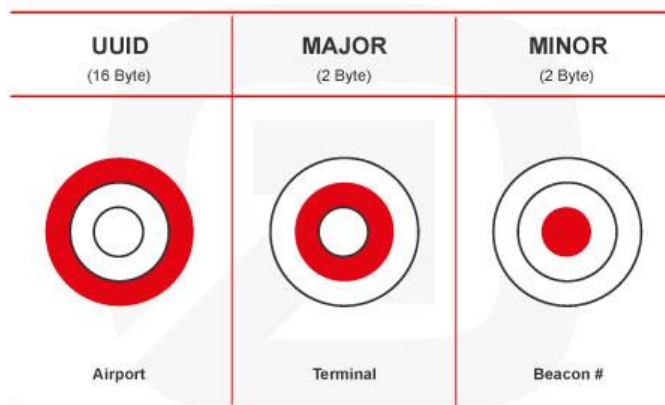
2. Interferences

Our clients frequently ask us if beacons possibly interfere with wireless networks and technical devices or if – vice versa – beacon signals can be disturbed by them. About the first case we can say: Beacons do not influence other signals or medical devices. But when beacons are installed in a room with a lot of Wi-Fi networks (for example at a trade fair), there can definitely be interferences, because BLE and Wi-Fi share the same frequency range (2,4 GHz). But the problem can be solved by avoiding the channels 2, 3, 4, 13 and 14 when configuring the WiFi network. Use channels 1, 6, 7, 8, 9, 10, 11 and 12 instead. Bluetooth automatically uses FHSS (frequency hopping spread spectrum) to evenly use the remaining channels. In the info graphic you see yellow channels (advertising channels used for indoor positioning) and blue channels (reserved for additional information such as temperature).



Frequency hopping - Bluetooth vs. WiFi (infographic by infsoft)

3. Configuration of iBeacons



iBeacons provide some codes which can be configured. You can see and modify them with a smartphone app or software from the hardware provider.

UUID: 16 byte string which indicates to which larger group (for example “airport XY”) a beacon belongs to. All beacons of this operator share the same UUID.

Major: 2 byte string which distinguishes to which sub-group some beacons belong to, for example gate 1 in an airport. It can also be used to differentiate between operation purposes.

Minor: 2 byte which identifies individual beacons. Each beacon has its own Minor with which it can be located in a map.

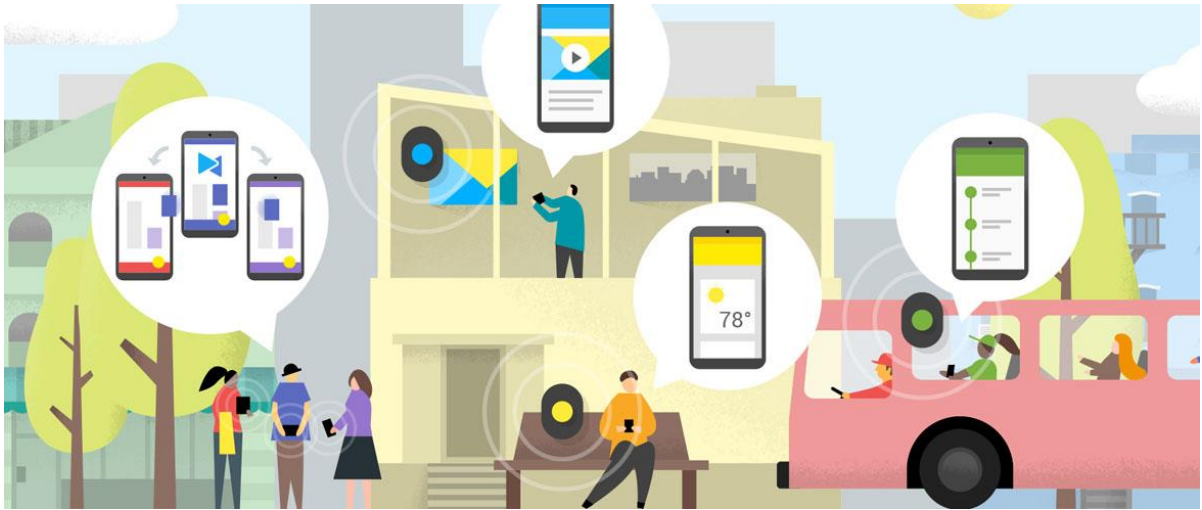
TX Power: Signal strength (RSSI - received signal strength indication) which is measured in one meter distance from the beacon. The configured transmission power can influence the positioning accuracy. Higher signal strength means higher energy consumption. TX power is being measured in dBm, for example -59 dBm indicates high signal strength, whereas -81 dBm is rather low.

Transmission interval: indicates in which intervals (for example 1000ms) a beacon sends signals. Higher transmission interval means higher energy consumption and faster positioning.

Eddystone beacons provide some “frame types” which are different from iBeacons.

Eddystone-UID: (16 digits long number which indicates to which group one beacon belongs and its individual ID)
Eddystone-URL (freely selectable URL) and **Eddystone-TLM** (current status of the beacon). Read more about [Eddystone's frame types on Github](#).

2.13. GOOGLE PRESENTS ITS NEW BEACON SYSTEM EDDYSTONE - NEW STANDARD IS FULLY COMPATIBLE WITH ALL SOLUTIONS BY INFOSFT



Google's new product Eddystone. Source: [Google Developers](#)

In the mid of July 2015 Google has presented its own beacon system. The company now offers a competing product for Apple's iBeacons, which have appeared on the market about two years ago. Unlike iBeacon, Eddystone is an open source product. Which means it is based on an open source code which has been published on [Github](#). Furthermore, it works platform independent, this means that it supports not only Android, but also iOS and all other devices using BLE (bluetooth low energy). Moreover via "Ephemeral Identifiers" (EID) it can identify and address individual devices out of the mass.

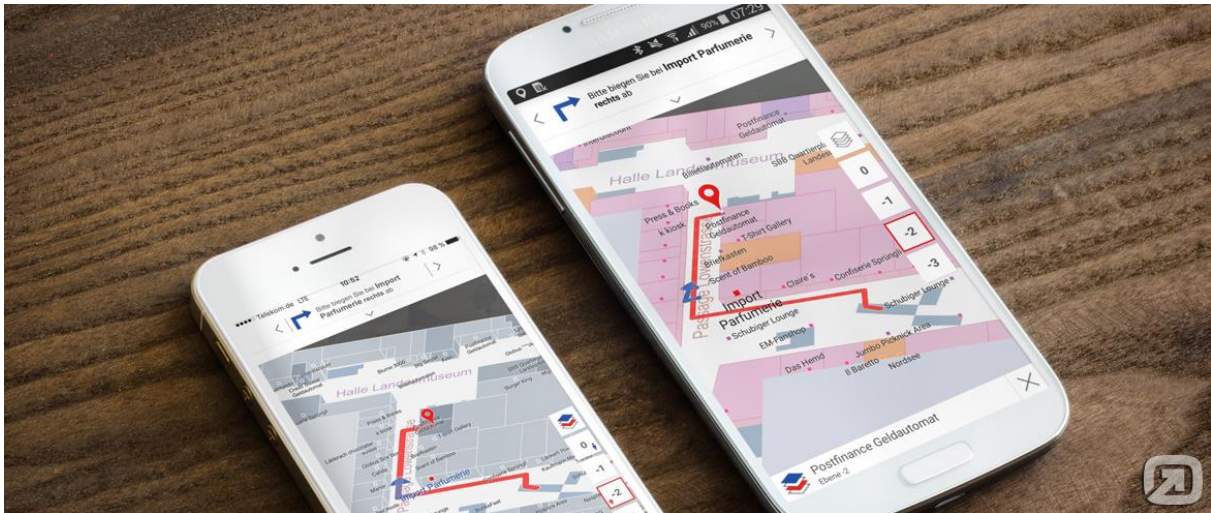
Eddystone beacons: fields of application

Beacons are small transmitters which send signals to smartphones by means of bluetooth low energy (BLE). Beacons have a range of about ten meters indoors. Until now, the signals only consisted of a serial number which enabled positioning. Google's Eddystone beacons furthermore can transmit a URL. That enables displaying location based ads or information even if the user has no special app installed.

Application examples:

- Location based advertising and services in shopping malls, airports and railway stations
- Indoor navigation and indoor positioning in complex buildings, for example fair grounds
- Asset and staff tracking in offices and industrial sites
- Analytics of visitor flows for example in the security areas of airports
- The complete range of products of infosft is compatible with Eddystone

2.14. INDOOR NAVIGATION WITH ANDROID AND IOS DEVICES – WHAT ARE THE DIFFERENCES AND FIELDS OF APPLICATION?



Finding the most suitable positioning technology is the critical success factor for indoor navigation projects. The most common ones are Bluetooth-Low-Energy (BLE) beacons and WiFi. But which technology is the best for each mobile OS?

In December 2015 iOS and Android had the following market shares in Germany: Android 72.6%, iOS 20.2%. In Japan however, Android makes up only 44.4% and iOS equals 54.1%. When you decide for a positioning technology, you should consider the number of users which it potentially excludes. [Have a look at the statistics.](#)

Indoor navigation with Android

Client based indoor positioning on Android devices is fuss-free. The operating system supports all common methods, for example beacons, WiFi and Visible Light Communication. Server based positioning, for example used for tracking people and objects, is also possible. Indoor positioning with WiFi has one big advantage: In most cases existing infrastructure, for example WiFi access points, hotspots or even cashier systems with internet access can be used. The device doesn't have to be connected to the WiFi network, it is sufficient when WiFi is active.

Summarizing the above, it can be said that WiFi is an affordable indoor positioning technology in most cases. But unfortunately, it is not very accurate: it can reach 5 – 15 meters. But the bigger problem is that client based indoor positioning with WiFi excludes all iOS devices. Thus, this solution is only worth considering when Android devices make out a very high percentage – for example at museums which provide their visitors with their own devices or in countries such as Brazil, where the market share of Android is over 90 percent.

Indoor navigation with iOS

Devices with iOS 4.3 and higher do no longer support client based positioning via WiFi. Server based tracking however is possible. Apple exclusively supports client based indoor positioning via beacons. iBeacons and Eddystone have an accuracy of 1 – 3 meters and are very flexible. Apple has for some time been working on its [own indoor mapping tools](#) which will certainly provide new impulses to the topic.

CONTACT



infsoft GmbH is located in Großmehring near Ingolstadt (Germany). It has been offering solutions in the area of indoor navigation, indoor analytics, indoor tracking and location based services since 2006. Besides the development of all-in-one solutions for major clients, infsoft offers scalable Software Development Kits (SDK), which lets developers integrate our key technologies into third party applications.

Frankfurt Airport, Vodafone, Swiss Federal Railways (SBB) and Daimler are among our long-standing clients.

Indoor positioning systems allow a better orientation in complex buildings and enable new applications in the field of location based services and -marketing. infsoft created the "smart connected locations" approach, which means that all backend tools and gained data are connected and interchanged in order to create added value - going beyond the blue dot in a map.

phone: +49 (0) 8407 - 939 680 - 0

mail: contact@infsoft.com

web: <https://www.infsoft.com/> | www.indoornavigation.com

infsoft GmbH
Ingolstädter Straße 13
85098 Großmehring
Germany

Responsible for the content: Tobias Donaubauer

