ODTUG GeekAthon Solutions Document
Team: Father and Son

This document describes the entry for the ODTUG GeekAthon Competition involving the use of iBeacons.

Team
The consists of Michiel and Dick Dral.

Michiel Dral is 19 years of age, but yet a seasoned programmer. At primary school he started his IT career with GameMaker. At thirteen years of age he got into jailbreaking iPods and iPhones. At fifteen he had his own Minecraft server hosting company, for which he learned some Java, Scala, Linux, PHP… whatever was necessary... Through creating mobile websites with PHP and MySQL he is currently programming mostly in React, Javascript and React Native. Since two years he is teaching programming to people all over the world, and enjoying it really well.

Dick Dral (58) has been working with Oracle since 1988. Through Oracle Forms and Designer he arrived at Oracle Application Express in 2006, and has stayed with that ever since. Since 2008 he is an independent contractor and almost all of his assignments he uses Apex. In the Apex Dashboard Competition he ranked second.

Problem
Finding someone to talk to about a subject you both are interested in. The pairing is purely on subject, location and language. Both partners are directed toward a meeting point using GPS navigation. The last tens of meters of the navigation will be done using the iBeacon, because GPS is very inaccurate at short distances.

BlindDate
Imagine you are in town on your own and you would like to meet and talk to somebody. There are many people around you and sure some of them are interested in the same subjects as you are. But how do you know who and where they are? You cannot see their thoughts.
Here is where BlindDate (BD) comes to the rescue. People can create a profile on BD, registering age, gender, spoken languages and subjects of interest. All users are provided with an iBeacon.

Based on profiles of registered users BD supplies you with a list of people that are in walking distance, speak your language and share one or more interests. To avoid prejudices no picture is shown. After starting the app you can chose a subject you would like to talk about. If there is another user nearby interested in the same subject, than BD picks a meeting point and both users get a map with directions to the meeting point.
The user that arrives at the meeting point first will locate no beacon. So he or she just sits down at the meeting point. When the other user arrives at the meeting point, he gets directions to locate his partner in the form of a sort of compass indicating direction and

distance. A special iBeacon Locator algortihm is used to determine the location of the iBeacon.

Architecture

The BD system consists of data stored in Oracle database and maintained with an Oracle Application Express application. The users use an app on their smartphone built with React Native. The app and the database communicate with JSON provided through ORDS.

The matching process:

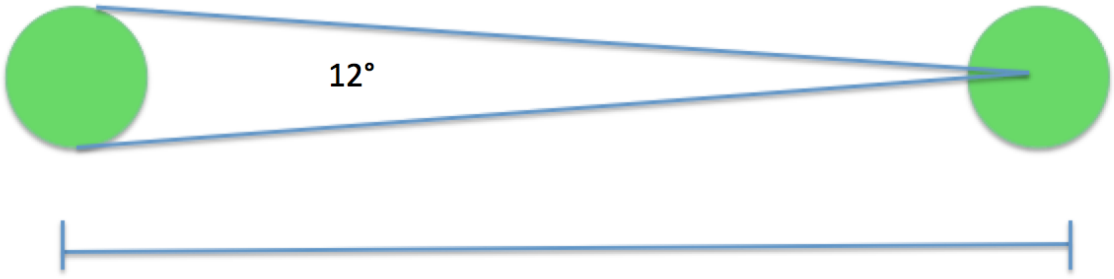
- Users which are open for conversation start the app. The app send the current location to the server. Changes in location are also sent
- When a user searches for a partner a request is sent to the server. The server replies with a list of suitable subjects
- Another user is notified there is a match
- The system selects a suitable meeting point in between the locations of the two users
- On both smartphones a map with both locations is shown
- The user's start walking towards the meeting point
- The first user at the meeting point sits down or stays put
- The other user is guided by the iBeacons the last meters to meet his partner
- The smartphones can be put away and the real world conversation can begin

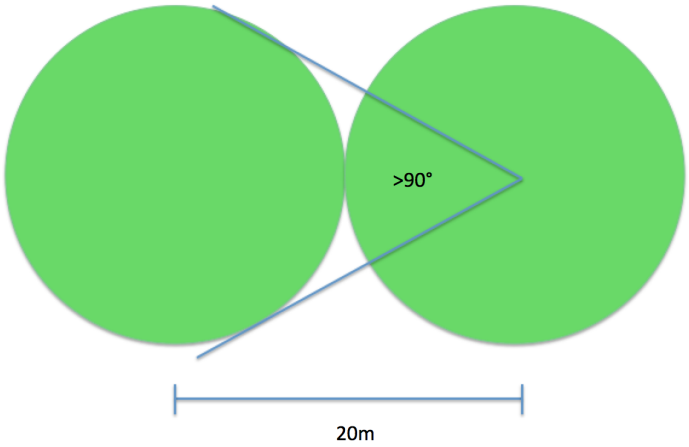
Guiding users toward each other

The system guides the users towards each other using GPS for long range and iBeacons for short range navigation.
The accuracy of GPS is limited from 10m to 30m , certainly in environments with high buildings [1]. Due to this limited accuracy the direction of the other person is very inaccurate at short distances:

[1] Accuracy of GPS on smartphones
https://communityhealthmaps.nlm.nih.gov/2014/07/07/how-accurate-is-the-gps-on-my-smart-phone-part-2/

Accuracy of GPS in cities
http://geoawesomeness.com/how-accurate-is-your-smartphones-gps-in-an-urban-jungle/





With a GPS accuracy of 10m at 100m the direction has an accuracy of 12 degrees, at 20 m distance the direction can be within more than 90 degrees. So at close range GPS cannot be used. Worst case you can pass each other at 15-20m which means that you could walk on different sides of the same road. In a crowd it also would not be possible to locate each other.

The last tens of meters are bridged using the iBeacon. Unfortunately the position of an iBeacon cannot be determined.
The iBeacon sends a signal like a lighthouse. This signal can be received by a smartphone. The smartphone does not know the direction the signal came from. Luckily the strength of the signal is an indicator for the distance. The signal strength decreases with distance. [2]
This gives us a rough estimate of the distance. There are apps available that do a pretty good jobs in providing the distance to an iBeacon, like Locate on iPhone.

This estimate can be improved in several ways:

- Both users have an iBeacon, so we have to distance estimates
- We can combine the measurements in time and average them
- We can combine the measurements with the GPS location

[2] http://developer.estimote.com/ibeacon/tutorial/part-3-ranging-beacons/

Locating your partner using iBeacons

The last tens of meters the users will be guided by the iBeacons.
The cumulative data of GPS and both iBeacons enable the system to guide the second user to the first. The second user has a kind of compass on his screen indicating the direction of and distance to the first user.

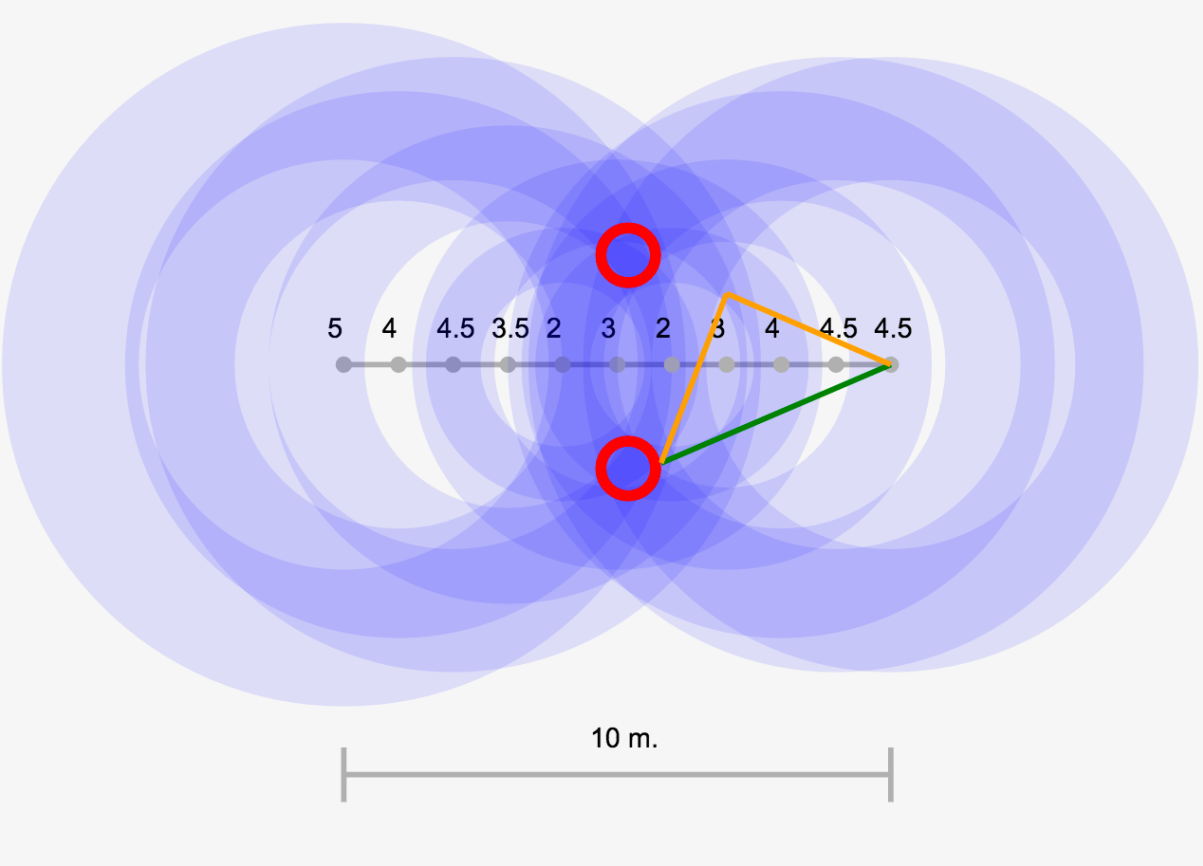
The technique behind this is a bit more complicated. iBeacons send out a signal with their ID. So it is possible to identify the iBeacon. The distance to the iBeacon can only be estimated using the signal strength. On the iPhone an app like Locate enables you to get an estimate of the distance of the beacon. We have used this app to test the locator function for BlindDate.

The locator function combines a number of distance measurements from different locations, taking advantage of the fact that one of the two partners is moving, and the other one is static. We also take advantage of the fact that both smartphones supply a distance reading, which improves the accuracy.

The locator function assumes that the walking partner is moving in a straight line at about 1 m/s (3.6 km/h). If the distance is sampled each second we get a distance reading each meter. These distances can be plot as circles around the measuring point. It is presumed that the accuracy is from -25% to +25%, so the circles are plotted as wide bands. These bands display the possible location of the beacon for that measuring point.
These bands have a small opacity, which decreases when the band gets broader. Wherever the bands overlap the color gets more intense. The location where the color is most intense is the most probable location of the iBeacon. This is indicated by the red circles (notice there are 2 circles).

Using the locator function there are two possibilities:

- The distance to the beacon keeps getting smaller until it is less than 1 m. This means you walk straight up to the beacon.
- The distance to the beacon reaches a minimum and then increases. After a few samples, it is clear that the beacon is passed. The locator determines the most likely location of the beacon and passes this direction to the user. Now we can't tell which of the two points is the right one. So the locator just picks the one which is most likely using the GPS location. Then we have two possibilities:
    - If the distance gets smaller in accordance with the walking speed, the user walks straight to the beacon (the green line)
    - If the distance get smaller in a much lower rate, then we are walking towards the wrong point. Then the locator can calculate a new course, that will lead the user straight to the right location (the orange line)



Brought to you by team Father and Son

Dick Dral
Blog: dickdral.blogspot.nl
E-mail: dick.dral@detora.nl
Twitter: @dickdral
Linkedin: Dick Dral

Michiel Dral

E-mail: michiel@dral.eu
Twitter: @dralletje
Github: dralletje
Linkedin: Michiel Dral