BLE-beacon reliability test report

This document describes methods and results of BLE-beacon (Bluetooth Low Energy) reliability test. The test is part of project SPARK, the next generation parking space by TUT (Tampere University of Technology).

Test purpose

In SPARK, there is a BLE-beacon placed in a car using the system. The beacon is advertising car's register number, making checking car's parking validity easier for the parking attendant. Placing BLE-beacon inside a car may reduce its range significantly, because car creates a Faraday's gage around the beacon. Before starting with actual implementation of the system, it is important to verify that BLE-beacon placed in the car can be detected reliably outside of the car within a reasonable range. Otherwise BLE-beacons could not be used to indicate that car is using SPARK, and other technologies should be used.

Methods

BLE-Beacon was placed in various places in the car. The places were on the dashboard (image 1), inside hand closet, behind the front register plate (image 2) and under the hood (image 3). The beacon was configured to advertise the register number every 5 seconds with transmission power of -12 dBm, which should have range of 15 meters without obstacles.

The iBeaconCFG Android application was used to scan for nearby Bluetooth devices. The tester started walking away from the car, straight away from the front of the car. Bluetooth devices were scanned after every meter. If the beacon was detected within 10 seconds three times in a row, connection was considered to be reliable. The tester kept walking further until scanning started taking too long. The latest reliable distance was marked down as the maximum distance.

Purpose of the test is to proof that BLE-beacons can be detected outside of the car, proving the concept. Therefore, distances were not measured accurately, but only estimated by the tester. More sophisticated testing with accurate measurements and various transmission powers can be made at a later stage of development. The weather during the test was cloudy, sprinkle rain and no snow. Test needs to be repeated in snowy conditions to verify functionality when car is covered in snow.

Image 1: BLE-beacon placed on the car's dashboard.

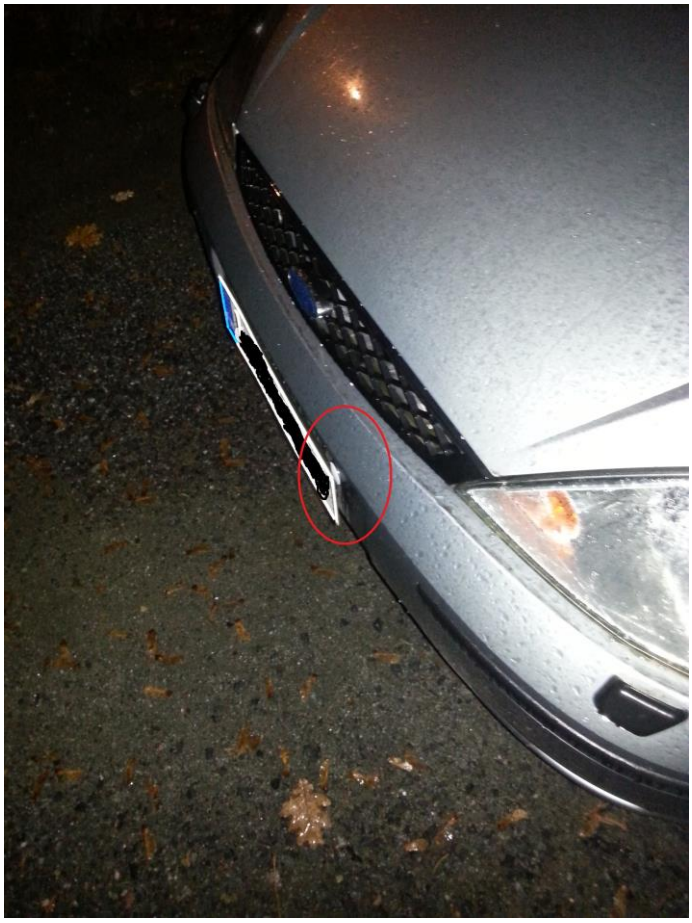

Image 2: BLE-beacon placed behind the car’s front register plate.

Image 3: BLE-beacon placed under the hood.

Results

Maximum distances are shown in table 1. As we can see, BLE-beacon could be detected in all test cases. Four to five meters away from the car is good enough in attendant's point of view. Placing the beacon behind register plate produced approximately as good results as without any obstacles.

Table 1: Test results using transmission power -12 dBm.

Location	Approximate maximum distance
On dashboard	5 m
In hand closed	4 m
Behind register plate	> 15 m
Under the hood	4 m

Conclusions

Test results show that BLE-beacon can be detected reliably from a reasonable distance in parking attendant's point of view in all test cases. Reliable distance varies significantly depending on beacon's location in the car. Snow on the car may further decrease the reliable distance.

The most promising location for the beacon seems to be behind the register plate. Snow is also expected to have the least effect on reliable distance in that case. However, placing beacon behind the register plate makes it necessary to protect the beacon from dirt and extreme cold, which may affect the reliable distance. Installing beacon behind the plate after battery change etc. is laborious, and makes using beacon less attracting to the drivers.

Test results are promising enough to continue SPARK development using the current concept.

Further testing

More tests are required to verify reliability in snowy and/or cold conditions. Used transmission power (-12 dBm) is fourth lowest transmission power level. Lower transmission powers should be tested to see if beacon's energy consumption could be reduced.