

# Trustworthy BLE Beacon Protocol for Resilient Positioning

Degree programme : BSc in Computer Science

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Public transport ticketing is being more and more digitized. This offers new possibilities, but also brings new challenges. One of these being the difficulty for passengers to maintain travel anonymity. Our work proposes a reliable and privacy preserving positioning system, which can be the foundation for a next generation ticketing solution.

## Introduction

Currently, there is no digital option for people, that would like to travel without having the journey linked to an account. This is particularly concerning, given ongoing talks about phasing out paper tickets by 2035. Meanwhile, “**Check-In, Check-Out**”- (CICO), as well as “**Be-In, Be-Out**”-apps (BIBO) such as **EasyRide** are getting more and more popular. Most of these apps rely on GPS for positioning and sharing this data with public transport companies for fare calculation. Not only is GPS easily spoofed, enabling fraud, but the location sharing undermines any travel anonymity.

## Travel without a Trace

Our work explored the possibility of a positioning service using Bluetooth Low Energy (BLE) beacons. Installed on public transport vehicles, they broadcast positioning and journey information. A passenger's mobile phone receives these, which enables it to determine its position. This all without the mobile phone revealing anything about itself. To make the broadcast information reliable, a cryptographic signature is included, which the mobile phone uses to verify integrity and authenticity.

## Results

Our work enables passenger's devices to reliably track their position for ticketing purposes. This information never leaves the passenger's device, ensuring full control over their data. Ticket inspectors can still validate a passenger's correct participation in the system to ensure compliance. We developed a working prototype system emulating a public transport vehicle and a mobile phone app that receives, validates, and displays the received journey information. During our research, we identified several challenges relating to **BIBO** systems in general. One of these is an inherent difficulty in determining if a person is an actual passenger or just a bystander, following a public transport vehicle. For example, a cyclist stuck behind a bus. Without the positive intention of a pas-

senger checking in, a **BIBO** system has no exact way of telling them apart.

## Future

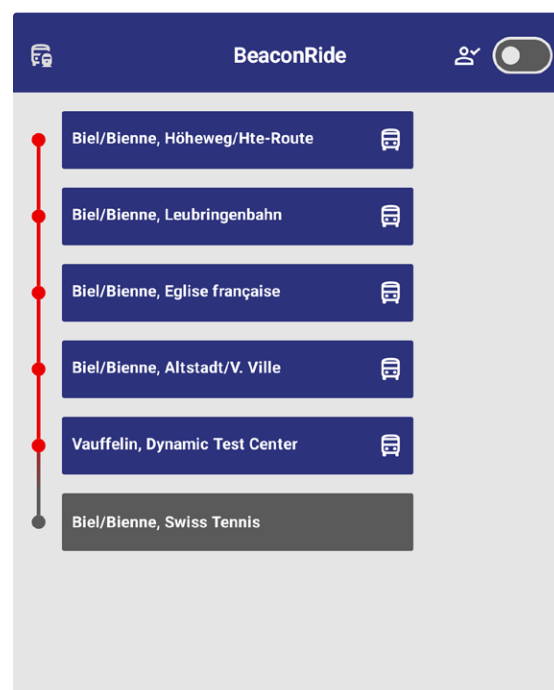
Our positioning system provides the foundation for a next-generation ticketing system, respecting the passenger's travel anonymity. One of the remaining challenges for such a ticketing system is the development of a payment process, which doesn't leak travel information to public transport companies.



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Screenshot from BeaconRide - our client side mobile positioning application.