

Development and implementation of an iBeacon based Time Keeping System for Mountain Trails

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Abstract. Time Keeping is an essential functionality for many kinds of competition sports. Within the TU Dresden Project “Modelling of Physical Health Parameters Based on GIS and Sensor Technology“ (Hessing & Buchroithner 2011) a new and unique system for outdoor sports on defined trails was developed.

The most important feature required is a permanent infrastructure on the respective running trail which interacts with a smartphone App on the user’s device, a web-based database and an interface. Using iBeacon technology, an easy-to-maintain infrastructure for time keeping on mountain trails and running courses was built at the “AktivArena Oberammergau” in the German Alps. The system is available 24/7/365, and not only for race or dedicated events. Users can compete with other runners or hikers at any time and see their results immediately on the web platform. The course has the character of a reference trail with known best times of professional trail runners and thus one can compare her/his personal trail running time. The www-based social media platform “meinBerglauf.de” is an ideal approach to compare results. The fact that the trail is a reference course with a defined start and finish distinguishes it from services like Strava or Runtastic.

Key-technology within this project is the use of wireless iBeacons, a standard for Low Energy Bluetooth (BLE), which was established by Apple Inc. 2013.

As a byproduct, a lot of individual information about the users’ physical capabilities for sports and medical scientific research purposes is generated. The defined “meinBerglauf” courses can be used as an environment equal to a sports lab. Using the runners’ bio-parameters like heart rate and running speed, their weight in kg and body size in cm, the algorithms for the model the users’ physical health parameters can be calibrated for runners in mountainous terrain.

Consequently, the presented project comprehends two aspects: 1. Bringing a new commercial product for time keeping for outdoor sports onto the market and 2. Scientific research concerning sports-medical issues in outdoor sports.

Keywords. iBeacon, Sports, Time Keeping, GPS, Navigation, Outdoor, Fitness, Company health program, smartphone App,

1. Introduction

Time keeping systems for sports competitions require a technology that provides a “link” to the individual athletes, so that every person can be identified at the start, along the track and at the finish line. An individual time stamp must be generated within an acceptable accuracy at a pre-defined location in the moment when the athlete passes. Time stamp and the athletes identification need to be stored in a database for further computing. On race tracks and for a dedicated event a high tech infrastructure for the time keeping can be set up. People can operate the computers and sensors along the track and huge batteries and generators can supply the energy which is necessary. The athletes need to be provided with a minimum of additional weight they have to carry. The here described system “meinBerglauf” offers a totally new concept for those demands.

2. “meinBerglauf”

2.1. Conventional Time Keeping

Most Time keeping systems for running or cycling competitions are usually based on RFID technology (*radio-frequency identification*). The start number plates are equipped with an RFID transponder which identifies the individual start number of the participant. The RFID transponder is a very small, lightweight and passive chip that doesn't require any power supply or battery. The necessary electric power to read the data programmed on the transponder chip comes from the RFID reader which is installed at least on the start and finish line of the race course and eventually on some places on the course. The coupling between transponder and reader occurs through alternating magnetic fields in short-range or high-frequency radio waves which are generated by the reader. That way the transponder is supplied with energy from the reader and the data from the chip are transmitted to the reader. The time keeping is based on the registration of the RFID transponders when they pass start and finish line: The information stored

on the transponder identifies the individual runner and the time stamps of the registration supply the timing.

The advantage of this system is that the core technology is stationary in the reader and the infrastructure behind and the mobile component is very small, handy and does not need any maintenance or power supply.



Figure 1: RFID transponder (<https://de.wikipedia.org/wiki/RFID>)



Foto © MaxFunTiming

Figure 2: RFID reader (www.kleinezeitung.at, time keeping at "Kärnten läuft")

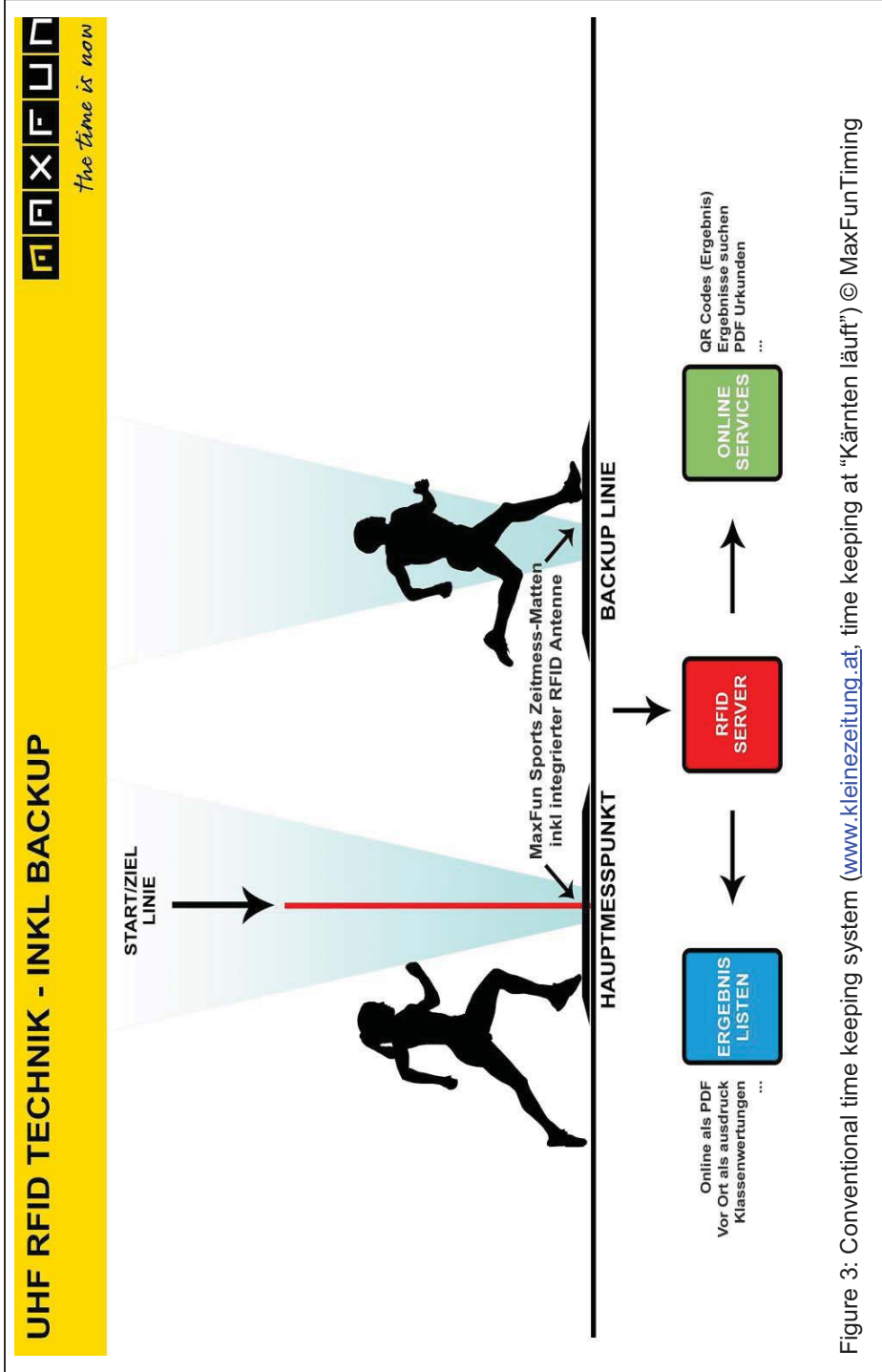


Figure 3: Conventional time keeping system (www.kleinezeitung.at, time keeping at "Kärnten läuft") © MaxFunTiming

2.2 The Approach

The approach of this study is the development of a time keeping system that can be used in remote places with a minimum of maintenance needs and no transponder or any other hardware should be necessary on the user/runners' side except a smartphone. That led to the concept of turning around the conventional time keeping concept: The passive component, a transponder or something else, should be placed on the trail running course. The active component should be the runners' smartphone.

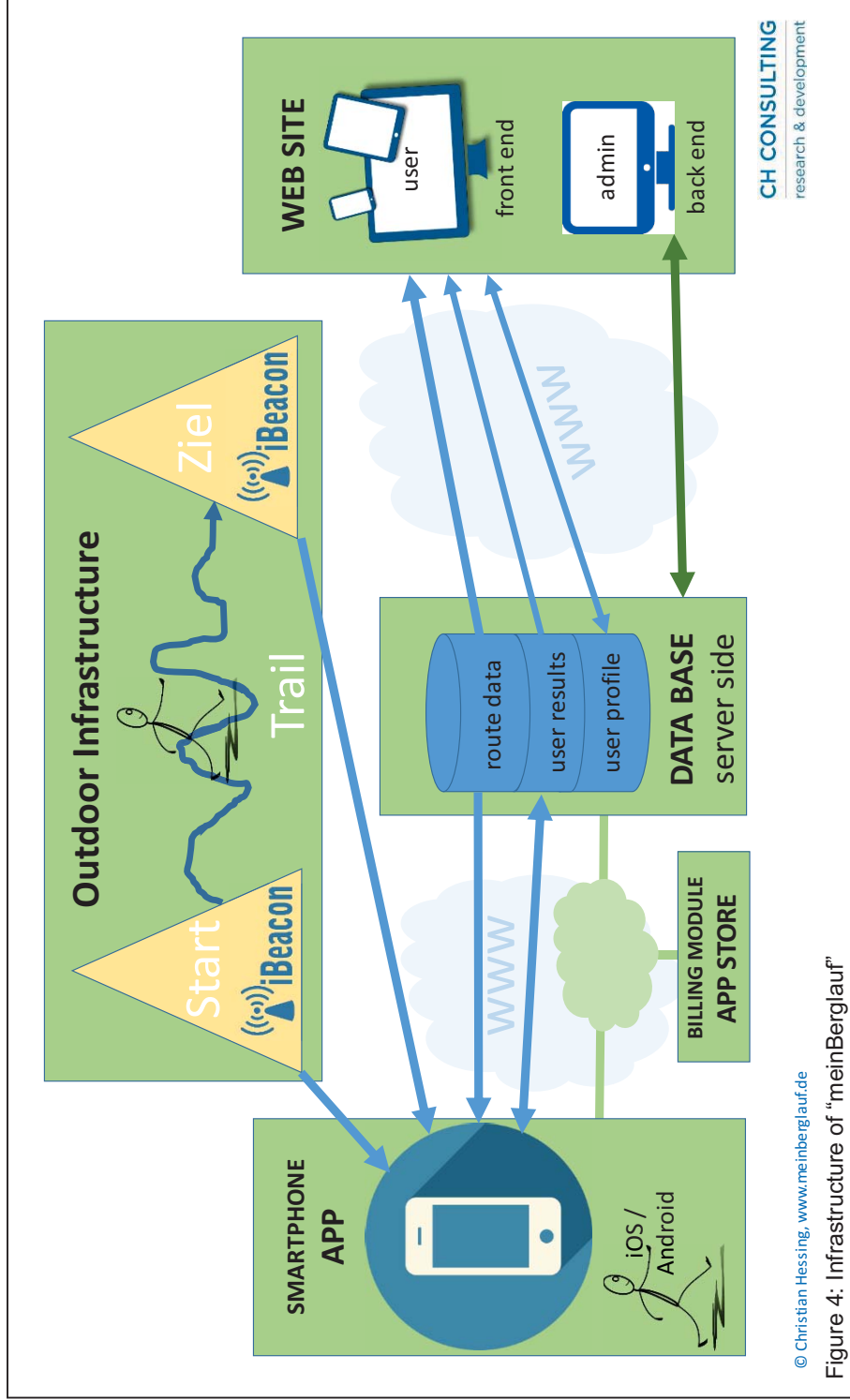
To set up a prototype of a demonstration system, a test course was established in the German Alps in Oberammergau at "Kolbensattel, Activ Arena". We installed two pillar like constructions at the start point of the test and reference course: One at the start place close to the parking lot of that tourist area and the other at the finish line on the mountain, close by a mountain hut.



Picture 1: Start and finish pillars on the test course in Oberammergau

After evaluating several systems, NFC tags (near field communication) were excluded because they are not supported by Apples iOS and RFID transponders because they need dedicated readers which are not standard in modern smartphones.

Finally, the iBeacon technology was the most appropriate solution for this approach.



The brand name “iBeacon” was established in 2013 by Apple Inc. and is a pretty new standard for indoor navigation. Based on Bluetooth Low Energy (BLE) the beacons can transmit digital information that was stored on the device. The broadcast interval can be defined up to 10 Hertz so that a sufficient accuracy for the time keeping for trail running needs can be reached

2.3 Use Cases and Target Groups

Leisure Trail Running and Amateur Sports

Trail running is very popular today. Only in Germany the number of active amateurs is estimated up to 50.000. In Bavaria, about 5.000 runners are frequently participating in mountain trail running competitions. For those enthusiasts the “meinBerglauf” infrastructure offers a platform to compete with others at any time. Due to the fix installed infrastructure a runner can set his best mark at any time. And this is how it works:

Before the first use of the system

- the user needs to register at www.meinberglauf.de
- install the APP on his Android or IOS smartphone

At the start beacon

- start App on the smartphone
- App indicates the start beacon (radius 5m)
- pack away the smartphone and get ready to go
- approach slowly towards the start beacon and enter the near range
- listen to acoustic start signal
- acoustic start signal indicates active time keeping.

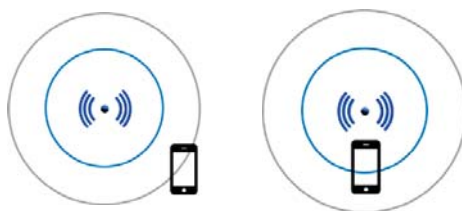


Figure 5: Approach and near range of the start beacon`

At the end of the trail

- enter near field range of the target beacon

- wait for the acoustic signal
- the resulting running time is displayed in the smartphone app
- the results are uploaded to the www.meinberglauf.de

On the web interface the user's results are displayed and interpreted in various ways. Very important for many users is the ranking, which makes every run a competition within all members of the participating trail running community.

Professional Training

The fitness and endurance training of professional athletes can be monitored perfectly on the "meinBerglauf" reference trails. The amount of energy needed for a dedicated speed in any segment of the trail can be calculated based on geodata and measurements. So the athletes and their coaches can optimize the performance of training and competition.

Everybody's Health and Fitness

Recreational hikers, mature people and everybody who wants to keep an eye on his weight control and health can profit from the "meinBerglauf" infrastructure. For those people a health and recreation app for smartphones will be developed. Many people used to start their hike with a speed much too fast for their potential and slow down when they get too exhausted. So at the end of the day their activity was not as efficient or healthy as it could have been. With the "meinBerglauf" health app the user will be supported to moderate the moving pace on a healthy level.

3. Conclusions

Location Based Services as a generic term covers a wide range of topics. Sports, health and fitness applications are a new demand for LBS and offer a lot of potential for further investigations. The Bluetooth Low Energy (BLE) technology provides a basis for this new time-keeping concept. Now experiences regarding accuracy and user acceptance have to be made. "meinBerglauf" is a first step for many further services based on LBS and sensor technology.

Hessing, Buchroithner 2011: Modeling of Physical Health Parameters Based on GIS and Sensor Integration, Proceedings of the 8th International Symposium on Location-Based Services, Vienna 2011