

Asset location using low-cost beacons, smart roaming devices and cloud computing

Final Year Project Preliminary Report

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1 Introduction

1.1 Purpose

The purpose of this report is to provide insight into the work completed thus far on the project. This primarily consists of research into potential architecture and technology.

1.2 Project aim

The aim of this project is to study the feasibility on the use of roaming mobile devices, roaming asset beacons and cloud computing to provide the locations of assets.

The location of assets in an area such as machinery in a distribution yard can provide useful information and metrics that allow the likes of asset utilization to be monitored and analyzed. Providing a system to do this often requires investment in specific hardware and infrastructure. However, using a few, roaming mobile devices to provide readings on mobile assets provides an interesting challenge.

Reading the data on the edge of the network is the easy part, the challenge lies in processing that data and reasoning to what degree of accuracy can an asset be expected to be in a location, given multiple readings over time from multiple mobile devices. Highly mobile assets would be much more difficult to track than slower moving assets.

2 Research and Analysis of Radio Frequency Communication

There are a wide variety of technologies used for wireless communication available commercially. Some of these technologies are very similar in nature but have very different use cases. These technologies have various ranges, complexities, costs and accuracies.

2.1 Requirements

As this project is exploring the use of low-cost beacons that require little installation and maintenance, the beacons must be reliable and simple. To allow for quick installation, a beacon should be a standalone unit capable of operating without the need for external power. As such it will need to be battery powered, and battery-life will be a primary consideration. Generally, range and battery life are closely related, as the larger the range of a devices the more power it will consume to reach this range, so battery capacity along with power consumption will dictate battery life.

The mobile device will likely need to be connected to external power, and can be assumed to have either a constant source of power (as in a machine when the machine is running), or some facility to charge the device. The mobile devices will need GPS radio in order to get a reading for it's own location. It will also need to have an onboard module capable of communicating with the asset beacons. The mobile device must have a data connection, either in the form of a SIM card based Network connection or WiFi.

2.2 Potential Technologies

2.2.1 WiFi

WiFi uses radio waves to exchange data between devices. Based on the IEEE 802.11 standards WiFi is commonly found in Computers and mobile devices. It is primarily used to connect many devices to the same network, typically to allow access to the World Wide Web. Typically these devices connect to a wireless access point within 100m. WiFi commonly uses the 2.4 GHz and 5.8 GHz bands.

2.2.2 RFID

Radio-frequency identification (RFID) uses a combination of readers and tags to identify objects. Tags are attached to objects to be identified and can be active or passive. Passive tags do not require a battery as they use some of the energy broadcast from the reader to send back a signal with their identification. As such, the greater the range desired from a passive system, the more powerful the reader needs to be in order to get enough energy to the tag, particularly if the location of the tag relative to the reader is unknown and the reader must broadcast over a wide area. Passive RFID is typically used where assets must pass through choke points, and the tag will not be far from the reader. Passive RFID systems typically have a range of 12m or less.

Active RFID tags use on board power to power their return signal. An RFID system using active RFID tags can be set up with a lower powered reader as the tag does not rely on drawing power from the reader. Active RFID systems offer a range of 100m or more.

2.2.3 Bluetooth

Bluetooth uses radio waves from 2.4 GHz to 2.485 GHz to transmit data. Bluetooth is commonly found in consumer devices and is typically used for pairing devices together over a short range – up to 100m outdoors. Bluetooth was designed with the purpose of replacing data cables, for example streaming music from a mobile device to a speaker. Bluetooth allows for 2 way communication between devices.

Bluetooth Low Energy (BLE) operates on the same frequencies as Bluetooth and offers similar range but with significantly less power draw. BLE is only compatible with Bluetooth version 4.0 and onwards, as the same hardware can be used for both technologies. BLE is intended for use in the IoT area.

2.2.4 Ultra Wideband

Ultra Wideband (UWB) is a wireless technology designed to transmit data over a short range. UWB uses multiple frequency bands which reduces susceptibility to noise. UWB operates in the range between 3.1 GHz and 10.6 GHz. Because UWB uses such a wide frequency band to transmit data, it can transmit through objects more reliably (such as doors) than other radio frequencies. Thus, distance between devices can reportedly be measured within 10cm