# Geo-fencing Infrastructure: Location Based Service

## Sachin W. Rahate, Dr. M.Z. Shaikh

*Computer Engineering Dept.Bharti Vidyapeeth College of Engineering, Navi Mumbai.*
*Principal, SBMP and College of Engineering, Mumbai*

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**Abstract** - *A geo-fence is a virtual boundary for a real- world geographic area. A geo-fence can be generated as per user's need by considering different radius, or a geo-fence can be a predefined set of boundaries. Geo-fencing is use of geo-fence. Geo fencing is a feature that uses the global positioning system (GPS) to define geographical boundaries. It has widely increasing scope. Very few applications are dealing with geo-notifications that are intended to inform the mobile/stationary user proactively about location- specific information. The technology behind proactive location-based services is called Geo-fencing.*

*Key Words*: **Geo-fencing, geo-notification.**

## 1. INTRODUCTION

Geo-fencing (geo-fencing) is a feature in a software application/program that uses the global positioning system (GPS) or radio frequency identification (RFID) to define geographical boundaries.[1] A geo-fence is a virtual barrier. Geo-fence apps and tools monitor when mobile devices or other physical objects enter or exit an established geo-fenced area and provide administrators with alerts or notifications when there's a change in status for a device. These alerts can be in form of text messages, e-mail notifications, phone calls or similar means of communication.

Geo-fencing is executed on the mobile devices. It includes the continuous positioning of the mobile device as well as the continuous matching of the mobile's position with a set of geo-fences. The mobile device is considered to be a client that is mainly responsible to locate itself whereas the continuous comparison of the mobile's position with a large set of dedicated zones, called geo-fences. Geo- notification plays very important role in geo-fencing.

Generally the geo-fencing refers to the idea in which the user defines the boundaries virtually over a geographical area, and once the transition is detected over a boundary the notification is send to performed the desired action .The paper is organized in following sections 1.location based services, 2.geofencing, 3.working, 4.applications.

## 2. LOCATION BASED SERVICES

Location based services (LBS) are services offered through a mobile phone and take into account the device's geographical location. LBS provide information. Because LBS are largely dependent on the mobile user's location, the primary objective of the service provider's system is to determine where the user is.[2]

These services can be of two types: Push and Pull. In a Push type of service, the user receives information from the service provider without requesting it at that instant, although the user may have originally subscribed to the service at an earlier time. The LBS advertisement is an example of a Push service. In a Pull type, the user has to intentionally request for information. The restaurant enquiry is example of pull type.

Location-based services (LBS), also known as location services, mobile location-based service,[3][4] wireless location services, is technology that provides information or generating information available based on the geographical location of the user.

LBS is a service trying to find out the answer to WHERE, e.g. Where is my friend Paresh? Where is the bank? Where the target customers of our company Location are, is so important to human lives that is essential to how people organize their surroundings.[5] It is of essential value that we can readily exploit to model reality.

Knowing geographical positional can provide huge potential to service provider. Location based services involve a lot of technology. To be successful, an LBS technology has to provide an accurate location, and suitable information for users required by the corresponding service, with minimal expenditure including establishing infrastructure and overhead.

Application of location based services

Marketing, Emergency, Information Services, Navigation, Location Based Social Media, Mobile Location-Based Gaming, Sports, Billing, Geo-tagging, Tracking.

## 3. GEO-FENCING

Geo-fencing combines awareness of the user's current location with awareness of the user's proximity to locations that may be of interest. To mark a exact location, it should specify its latitude and longitude. To adjust the proximity for the location, it should add a radius. The latitude, longitude, and radius define a geo-fence, creating a circular area, or fence, around the location of interest.

Geo-fencing is executed on the mobile devices. It includes the continuous positioning and/or tracking of the mobile device as well as the continuous matching of the mobile device's position with a set of virtual boundary i.e. geo-fences. Geo-fence can be circular or polygonal geo-fence. As shown in Fig. [1][2]. The mobile device is considered to be a client that is mainly responsible to locate itself and the continuously comparison of the mobile's position with a large set of *geo-fences.*

Geo-fencing is mainly the use of the Global Positioning System (GPS) satellite network and/or local radio-frequency identifiers (RFID such as Wi-Fi nodes or Bluetooth beacons)[7] to create geo-fence i.e. virtual boundaries around a location in map.

Geo-fencing uses GPS coordinates to encapsulate a geographic area and takes a mobile user's (who has opted in to receive push notifications)[8] location data via GPS to determine his/her proximity to that particular region (whether mobile user inside geo-fence or outside geo-fence or if mobile user just went in and came out of that particular area in a matter of seconds).

Example is shown in Fig-[3]

### Positioning Sensor Technology

Geo-fencing use-cases often involve the need to reliably and accurately track devices, both indoors and out. To do so, requires the ability to use multiple location data sources, both via the device's own sensors and 3rd party location sources, such as carrier networks, aggregators and proprietary 3rd party systems.[9]

### Elements in Geo-fencing System-

**GPS** – GPS can improve location accuracy to within 5 meters of mobile user's location and is easily available with no extra burden on carrier infrastructure.

**A-GPS** – Assisted GPS (A-GPS) supplements GPS satellite information with surveyed coordinates of cell/mobile tower sites to enable more precise server-based calculation of device position.

**Cell-ID(COO/CID)** – Device is located by identifying the network cell tower to which it is connected. CID positioning is simple, and can be done on the network or on the mobile user device and does not require upgrades to network location infrastructure or mobile devices. CID provides a very rapid response time.[14]

**Wi-Fi** – Wi-Fi reduces time-to-first-fix (TTFF) and is appropriate for indoor environments that obstruct satellite signals. Wi-Fi is also a viable option for outdoor positioning with the large availability of access points in urban areas. Enterprises can benefit by using existing investments in Wi-Fi networks as location infrastructure.

### Types of Geo-notification-

(1) Static geo-notification: This is based on the geographical position of a mobile user with respect to a fixed area. For
Example, notification is send to particular mobile user when he entered into geo-fence, for example student enter into school campus.[10]

(2) Dynamic geo-notification: This is based on the geographical position of a mobile user with respect to a changing data stream. For example, the "open parking space" notification that is sent to mobile users who happen to be driving nearby.

(3) Peer-to-Peer geo-notification: This is based on the geographical position of a mobile user with respect to other users. For example, go through notification of nearby friends on a social mobile app like Facebook, or Foursquare.

The geo-contextual trigger fires correctly is a function of:

**Location Accuracy** – The device location must be correctly determined relative to a geo-fence for the action to occur properly (i.e., the right user receives a notification)[11].

**Tracking Rate** – The cadence by which the device provides a location update to the server, a location is calculated, where the device is evaluated against eligible events (with associated actions)

**Device Speed** – The speed a device determines the time period within which the device must provide a location update to be evaluated against eligible events (with associated actions)

**Device Route** – The path a device takes across a geo-fenced area which affects the time period within which location update must occur. For example, the period is much shorter if the device follows the edge of a circular geo-fence rather than passing through the center.[12]

**Geo-fence Size** – A larger geo-fence provides a longer period for a location update, unless the device track skirts the edge of the geo-fence

Generally, geo-fence scenarios can be categorized based on their dynamics, delivery and time constraints. With each category having different implications on the architectural design of a Geo-fencing system. The dedicated zones of a geo-fence scenario might be fixed, e.g. a certain traffic signal on a route within a freight management application, or moving, e.g. a friend within an application for 'friend-close-by'-notifications. Geo-notifications can be delivered only once or every time a geo-fence is entered or left. Since our approach aims to support local retailers to emit location-based coupons, our system should support fixed dedicated zones like commercial districts and should be able to deliver a coupon only once or multiple times successfully traversed by a potential customer in geo-fence scenario. [13] In some cases, coupons and/or notification should only be delivered if the target remains within a geo-fence at least

for a minimum duration. Thus, a Geo-fencing system for a smart retail environment should also be able to monitor the dwell times of targets within geo-fences and cancel the coupon delivery in case the spatiotemporal preconditions are violated. [15][17]

Geo-fencing, in a security based model, provides security to wireless local area networks. This is done by using predefined borders, e.g., a company with borders established by positioning technology attached to a specially programmed server. The company enclosed area becomes an authorized location for designated users and wireless mobile devices.

## 4. HOW IT WORKS

GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use trilateration to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. Now, with distance measurements from a few more satellites, the receiver can determine the user's position and display it on the unit's electronic map.[18].

A GPS receiver must be in coverage of the signal of at least 3 satellites to calculate a 2-D position (latitude and longitude) and track movement. With four or more satellites in coverage, the receiver can determine the user's 3-D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.

The 24 satellites that make up the GPS space segment are orbiting the earth about 12,000 miles/ 20000 km above us. They are constantly moving, making two complete orbits in less than 24 hours. These satellites are travelling at speeds of roughly 7,000 miles an hour.

GPS satellites are powered by solar energy. They have backup batteries on-board to keep them running in the event of a solar eclipse, when there's no solar power. Small rocket boosters on each satellite keep them flying in the correct path.

Theoretically, there are no limits on the size of your geo-fence, but in the interests of maintaining accuracy we recommend a minimum radius of 10 meters and a maximum radius of 200 kilometers. When too small, there can be issues accurately pinpointing longitude and latitude and when too large, the curvature of the earth may present problems.[14]
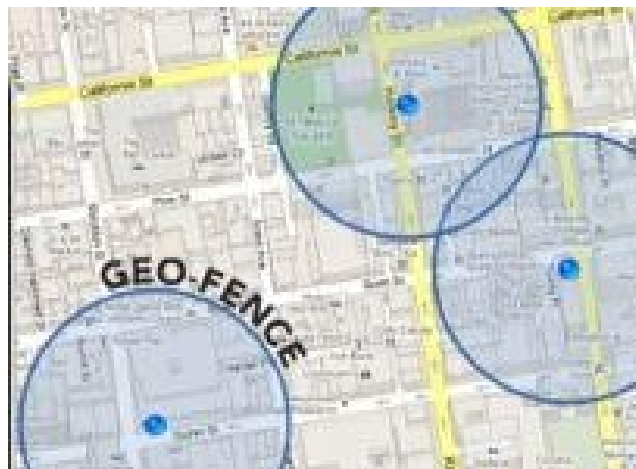


**Fig- 1 :** Circular Geo-fence



**Fig- 2:** Polygonal Geo-fence
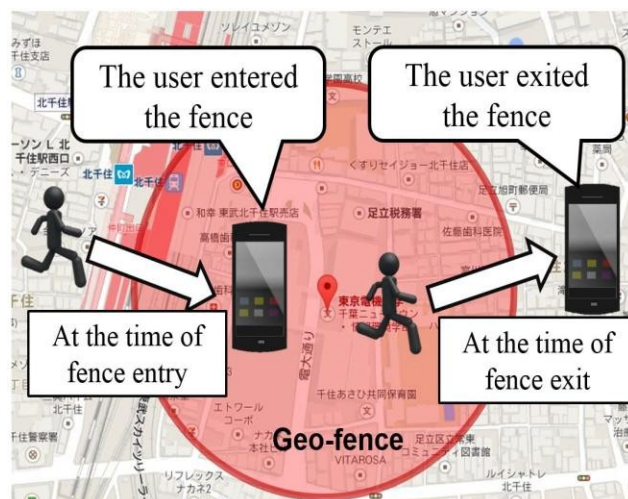


**Fig- 3:** Geo-fence Example

## 5. APPLICATION

-Geo-fencing, used with child safety, if child enter or leaves designated area then parent can get notification.

-Fleet management- When a truck driver breaks from his route, the dispatcher receives an alert.

-In Shopping tracker, user can get notification about shopping reminder for example Shopping list notification when user will be near to shopping location.

-In Marine safety service, if ship will moving towards restricted area or international border then before some predefined distance notification will be send to ship.

-Human resource management- An employee smart card or GPS tracking device will send an alert to security if an employee attempts to enter an unauthorized geo-fence/area.

-Compliance management- Network logs record geo-fence crossings to document the proper use of devices and their compliance with established rules.

-Marketing- A restaurant can send a notification or a text message with the day's specials to an opt-in customer when the customer enters a defined geographical area or geo-fence.

-Asset management- An RFID tag on a pallet can send an alert if the pallet is removed from the warehouse without authorization. [16].

-Law enforcement- An ankle bracelet can send notification or alert authorities if an individual under house arrest leaves the premises.

## 6. CONCLUSION

The geo-fencing technology provides simplified solution to all kinds of proximity and buffer analyses. It can be used for all mapped objects existed in charts vector data sets, both static and dynamic. It takes a major step from a mobile based towards an infrastructure-based Geo-fencing system. Mobile clients were designed which adjust their location update strategies to the recommendations of the infrastructure as well as to the different activities of the mobile client user.

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