# A REVIEW ON POSITION TRACKING METHODS IN ANDROID APPLICATIONS

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**Abstract** –

*In this era, the technology is growing and changing at almost every fraction of seconds. Nowadays we keep on hearing the word Android which is at its peak of success. Due to rapid growth and huge changes in Android, there are so many applications are available in order to track the location using different tracking methods. Tracking the mobile phone means attaining the current position of a mobile phone which is stationary or moving. Localization may occur either by calculating the differences of radio signals between one or several radio towers of the network and the phone, or simply via GPS. The main objective of location tracking Android applications is to provide guidelines to the person who is newer in the city and while travelling. This paper gives a literature review on the recent position tracking methods in Android applications. The characteristics of positioning methods are represented in tabular form for quick reference.*

**Keywords-** *Localization, Global Positioning System, Wi-Fi, Cellular Network Positioning*



## Introduction

The use of mobile technology and services serve as a communication platform which tremendously influence and improve the efficiency, effectiveness and productivity of work. Mobile applications is a term used to describe Internet applications that run on smart phones and other mobile devices which is also called mobile app. Mobile applications usually help users by connecting them to Internet services more commonly accessed on desktop or notebook computers, or help by making it easier to use the Internet on their portable devices. Mobile application development is one of the fastest growing businesses because of the large number of smart phones being sold. These portable devices are easy to use and allow users to customize the settings and features. Mobile application development is an open market. A mobile app may be a

mobile web site bookmarking utility, a mobile-based instant messaging client, Gmail for mobile, and many other applications.

Now the mobile has become the valuable part of the human beings. It has become inevitable for human beings to have a powerful device which will provide all the facilities other than basic facility available in mobile phones. Android provide such functionality which enables the developers to design such applications which will make a simple mobile to smart one. "Android is built on the open Linux Kernel. Furthermore, it utilizes a custom virtual machine that has been designed to optimize memory and hardware resources in a mobile environment. Android is open source it can be liberally extended to incorporate new cutting edge technologies as they emerge. The platform will continue to evolve as the developer community works together to build innovative mobile applications" [1] [2].

**Position Tracking Methods**

The common mobile device positioning technologies are GPS, WiFi positioning and Cell-Id positioning that are broadly used in smartphones today. They are briefly introduced and compared with all the features.

**A. Global Positioning System**

The most common and one of the important positioning systems today is GPS. The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. It is operated by the United States government and includes up to 32 satellites, which continuously broadcast signals from the so called the space segment. The GPS devices in the user segment that are integrated in most smart phones, receive those signals and can use a minimum of 4 or 5 signals to calculate a three dimensional location and the current time. Still it has some disadvantages compared to other methods. The three main disadvantages of GPS are Time to First Fix, availability and power consumption. TTFF is reduced to several seconds in the broadly used Assisted GPS (AGPS), but can increase drastically when no data connection is available since most Assisted GPS devices nowadays retrieve their assistance data through which is called Secure User Plane Location via IP. The newest generation of GPS devices is able to detect extremely weak signals. GPS is

usually not available inside buildings or urban canyons but functions properly outdoors. Although manufacturers of GPS devices try to improve energy consumption using GPS for positioning is comparatively expensive in terms of energy costs. This is still a major problem on mobile devices due to their limited energy resources. On the other hand GPS positioning is very accurate and precise and also available in rural areas without any network reception. It has a global coverage as long as the line of sight to the satellites is not obstructed [9].

**B. WiFi-based Positioning System**

Positioning systems based on WiFi use the wireless access point's MAC address to identify unique WiFi hotspots. Firstly the position of hotspot has to relate with a reference position like a GPS location fix and saved in a database. This is mostly provided by driving, where dedicated vehicles drive around systematically to create databases of position related radio signals. It can also created by crowd sourcing, where users anonymously and automatically send current positioning measurements to the provider of that positioning service. For positioning the location of the addresses of the received hotspot signals is looked up in that database to retrieve the according position. Some of the WiFi positioning systems also take the received signal strength of one or several access points into account. All WiFi positioning solutions have in common that they are broadly available with good accuracy in urban areas with many hotspots but cannot determine the position in rural areas with a low density of access points or no access points at all. Also the location of access points is subject to continuous change due to people who move with their access points to new homes or temporary hotspots that are only online when they are needed for example on trade shows. Therefore the lookup databases have to be maintained quite regularly to keep the positions of access points up-to-date. This problem will amplify in the near future with the upcoming of portable WiFi hotspots that share a cellular connection to the internet and more and more smartphones allowing the same [8].

**C. Cellular Network Positioning System**

Similar to WiFi positioning, cellular network positioning (Cell-Id positioning) uses a unique identifier of the base stations consisting of the mobile country code, the mobile network code (MNC), the id of the cell tower and its according location area identifier. That id initially has to be related to a reference position like a GPS position fix. With these unique identifiers, a

mobile phone can look up the currently received base stations in a database in order to retrieve the location via an IP-based network connection. Since reception areas of base stations are much larger than those of WiFi hotspots, Cell-Id positioning is very inaccurate but consumes little energy due to the fact that mobile phones make measurements about nearby base stations anyways quite frequently for handover or location management. Finally, it can be stated that a clear advantage of WiFi positioning in comparison to GPS is that it is also suitable for indoor positioning and has moderate power consumption, but on the other hand, it is not as accurate. Cell-Id positioning is even more energy-efficient. But accuracy in Cell-Id positioning is poor and ranges from several hundreds of meters in urban usage to several kilometers in rural area or sometimes there is no network coverage at all [10].

**Characteristics Of Positioning Methods**

All the positioning methods on smart phones which are discussed above differ in the previously introduced characteristics of positioning mechanisms as can be seen in Table I. Note that accuracy and precision are only values to compare the magnitude of the attributes of today's smart phones.

| Technology | Accuracy | Energy | Precision | TTF | Limitations |
|---|---|---|---|---|---|
| GPS | 10m | 94% | 16s | 6.599Ws | indoors |
| WiFi | 50m | 89% | 4s | 2.732Ws | rural areas |
| Cell-Id | 5km | 64% | 4s | 1.063Ws | regions |

**Table 1.** Characteristics of Positioning Methods

Especially the accuracy of WiFi and Cell-Id positioning can differ in areas with a low density of access points or cell towers. The energy consumption is described as the amount of energy that is needed to obtain one position sample based on measurements.

Figure 1 illustrates that the comparison of the introduced positioning methods can be seen as a pyramid with GPS on top, WiFi positioning in the middle and Cell-Id positioning at the bottom. The narrow part of the pyramid, which is represented by GPS stands for high energy consumption, high accuracy but a long TTFF and limited availability since it is not working indoors. At the bottom, the situation is vice versa, which is exemplified by Cell-Id positioning. In

the middle of the pyramid, WiFi represents a positioning technology with moderate accuracy and energy consumption. GPS could also work in an autonomous mode but that increases TTFF up to several minutes thus using a network connection for transmission of support data in A-GPS is reasonable. WiFi and Cell-Id positioning could also work in a standalone mode without IP connectivity but then a huge amount of reference data would have to be stored on the mobile device to lookup the location of the Cell-Id or WiFi MAC-address. Furthermore, it would need to get updated whenever changes occur. But at least it would make sense to cache lookup data for several hours or days since it does not change very frequently. However caching is not provided because the provider of the location is interested in frequent user.

**Mobile Positioning Application Programming Interfaces**

The Application Programming Interfaces (APIs) for positioning of broadly available device platforms are discussed and compared.

Location API for J2ME: In 2002, the Nokia Corporation proposed a java specification request (JSR) for positioning on mobile devices as an optional extension to J2ME, which resulted in the first version of the JSR-179 [1] final release in September 2003. Today, it still seems to be the basis for many positioning APIs. Its purpose is to provide a compact and generic API that produces information about the device's present physical location to Java applications and enables developers to write mobile location-based applications for resource limited devices. It consists of the package javax.microedition.location that contains classes for coordinates, orientation, general location providers, criteria to choose an appropriate positioning device and a database to store landmarks on a device. But it was not developed for energy-efficient tracking with several positioning technologies even though different positioning technologies could be implemented in one API through the LocationProvider class. An application developer can specify so-called Criteria to automatically select the most appropriate positioning technology by the API based on accuracy, power usage, ability to report altitude, speed, bearing and monetary cost, but the API is not meant to return more than one LocationProvider at the same time by the getBestProvider(Criteria criteria, boolean enabledOnly) method.

Location API on Android 2.2: Since the Android location API (package android.location1) obviously is based on the java specification request JSR 179, proactive LBSs were not developed for energy-efficient tracking with several positioning technologies even

though different positioning technologies could be implemented in one API through the LocationProvider class. The Android platform has implemented two different standard location providers by default, namely network and GPS. The network provider uses combined WiFi and Cell-Id positioning with an own lookup server [2].

Core Location on iPhone OS 4.2: The Core Location API of iPhone OS 4.22 only allows for starting and stopping a rather abstract location provider, the CLLocationManager after configuring the properties CLLocationAccuracy and distanceFilter. The location manager notifies the delegate of type CLLocationManagerDelegate whenever new position updates are available. The API encapsulates and manages the decision about the used positioning technology and ”probably” tries to save as much energy as possible with the given CLLocationAccuracy. However, that value may change drastically during runtime and therefore should not be described by a fixed value. Also the ReadMe.txt of the LocateMe example code states that “Power can only be saved by turning off the location manager”, which might be an option but then again leaves those decisions up to the developers. It is possible to make the application and positioning asleep in the background to save energy until a new cell has been entered and the application will be reactivated. This method is named significant location change and saves quite a lot of energy but leads less accuracy since location events cannot be generated while the application is asleep [1].

**Blackberry:**

RIM extends the JSR-179 in the package net.rim. device.api.GPS through the class BlackBerryLocationProvider, which allows to pause and resume the location listener. In the pause state, the application can specify that it wants to keep the GPS warm, if pauseLocationTracking is called with an interval greater than 0. Since Blackberry devices only provide GPS positioning by now, it is not relevant for this work. However, RIM might adopt new positioning technologies by partnerships with commercial location providers, for example SkyhookWireless.

**Geolocation API:**

Web browsers that have implemented the HTML5 standard of W3C also allow positioning via its Geolocation API. But since it only works, when a browser window is open and cannot determine a devices position in a background process, it is not suitable for our

tracking purposes and therefore can be neglected. In summary one can state that by using any of the different location APIs a developer always has to implement energy-efficiency for tracking on his own. Therefore the situation leaves enormous potentials untapped to save energy by mechanisms that could be implemented by experienced core developers of the underlying platform in a general way, so that developers could directly make use of them without taking too much care about low level positioning details.

**Windows Phone:**

The location API (System.Device.Location) of Microsoft's Windows Mobile 7 does not provide methods for continuous monitoring of spatial objects. Developers can only call the Start method of the GeoCoordinateWatcher class to start positioning and use the OnPositionChanged method to manually "track" every single location update.

**Power Management Of Location Tracking Methods**

A lot of research has also been conducted in the area of power management mechanisms for positioning. Zhuang et al. [5] use several power management mechanisms to decrease battery drain on an Android device. They also discuss the dynamic selection of location providers, but in a different scenario when some providers are not available and therefore try to learn context information that is used to turn off specific location providers if they are not available. They also synchronize the location requests of LBSs, which can reduce the number of requests and thus reduces energy consumption. EnTracked platform [3], for example achieves optimizations on a Nokia N95 in combination with its accelerometer for movement detection, which regularly polls the accelerometer for movement and turns GPS positioning off, if the device is not moving. Farrel et al. [4] studied to reduce the amount of energy consumed by a GPS receiver and the related transmission of data by user-defined error bounds to reduce the number of position queries on the device and updates to the server via network connectivity but at the same time satisfying certain tolerances in accuracy of positioning. By using the accelerometer, positioning is completely deactivated when the device is not moving. The fourth approach is called piggybacking and reuses live positioning information for several LBSs running in parallel. Although being effective, all of those approaches are not directly applicable to our addressed topic of efficiently monitoring spatial objects, but maybe some aspects of it can be integrated in future.

**Conclusion**

This paper presents a literature survey on the various techniques involved in position detection and tracking. Position detection and its tracking with accuracy is a hard task in case of extremely all conditions. As per the evaluation, GPS could work in an autonomous mode has the high rate of performance and the error rate is comparatively less than the traditional methods like Cell-Id and Wi-Fi.

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