



## A Survey of Positioning Algorithms on Mobile Devices in Location Based Services

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**Abstract:** *Location-based Services are one of the fastest growing areas of computing. There is an increasing demand to accurately and quickly determine the position of a mobile at low cost. Location-based applications are becoming popular and available and provide the user with a information based on their location. This paper describes about different techniques proposed for locating users. An Algorithm is then derived for deciding the best method based on user requirements. The Algorithm dynamically deactivates different positioning technologies and only activates positioning methods with least energy consumption. The Algorithm can reliably and accurately determine.*

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### I. Introduction:

The UMTS (Universal Mobile Telecommunication System) Forum defines location-based services as follows. Business and consumer 3G Services that enable users or machines' to find other people, vehicles, resources, services. This definition is somewhat narrow as it limits location-based services to 3G Services. In this, we will first look at different ways of obtaining the user's location information and how location information includes maps. There are varieties of methods available to locate the user services as GPS Locations, GPS-based solutions and Non-GPS locations such as Cell-ID, RX power levels, Angle of Arrival, Time of Arrival and solutions observed time difference on Arrival (OTDOA) and Wireless LAN based. For different types of services at different times it may be better to use one method over another. This depends on different factors including.

1. Required accuracy level.
2. Locality (Urban, Rural, GPS coverage blackspot).
3. Required time for getting the position.
4. Cost.

### II. Positioning methods:

They have different characteristics in terms of availability, accuracy, energy consumption and TTFF, they should be used in different ways to increase energy-efficiency. Hightower and Boriello Investigated amongst others several attributes of location systems for ubiquitous computing which also are of importance for this work:

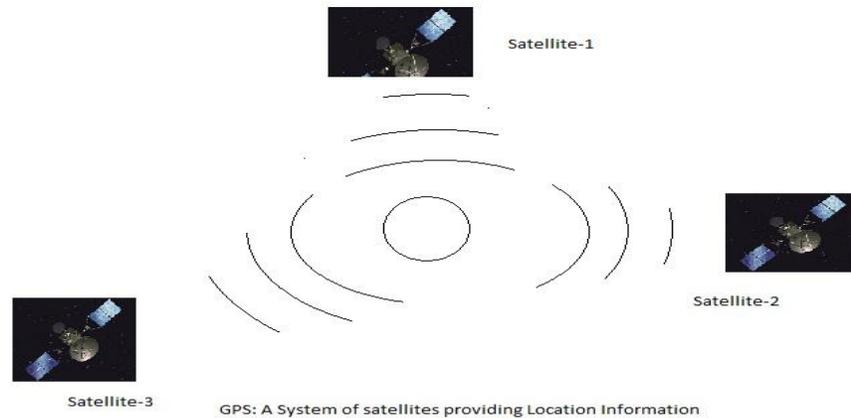
- **Accuracy:** the veracity of a determined position (deviation in meters)
- **Power:** average energy consumption per fix (usually in Milliwattseconds (mWs) or Millijoule (mJ))
- **TTFF:** time to first fix (time in seconds until location can be determined initially)
- **Availability:** situations where positioning is limited In the following, the principles of widely used positioning methods are introduced and discussed.

### III. Existing positioning Techniques:

#### a) GPS-Locations:

A mobile Device is not always at the same place its location is constantly changing. There are variety of methods for collecting and using the location of the user and the device. Imagine a system that can only give you directions to where you want to go if you know where you are or it would be too difficult to figure and your location. The device may be reset for a relative location if it has the ability to sense motion and can keep track of the change of location for some period of time after this reset. Most location-sensing technologies use one or more of three categories of techniques.

1. Triangulation
2. Proximity
3. Scene analysis.



- 1) **Triangulation:** Triangulation relies on age-old geometric methods that allow calculation of the location of a point that lies in the middle of three other points whose exact positions are known. If the distance to each one of the three points is known, we can use geometric techniques to calculate the exact location of the unknown point.
- 2) **Proximity Method:** Proximity based methods measure the relative location of the unknown point to some known point.
- 3) **Scene Analysis:** Scene Analysis relies on image processing and topographical techniques to calculate the location of the unknown point based on a view of the unknown point from a known point. The most well known location sensing system today is GPS. GPS enabled devices can obtain latitude and longitude with accuracy of about 1-5 meters. GPS has its roots in the military until recently the military placed restrictions on the accuracy of GPS available for public use. GPS devices use triangulation techniques by triangulating data points from the satellite constellation that covers the entire surface of the earth. If a device does not have GPS capabilities but uses a cellular network for wireless connectivity signal strength and triangulation or other methods can be used to come up with some approximate location information, depending on the cellular network.

**b) GPS-Based Solutions:**

A system of satellites is positioned around the earth with earth broadcasting a signal that can be used by a GPS-enabled device to determine its location. GPS devices typically use the signal coming from three or four different satellites. Sometimes the device itself does the triangulation and sometimes it sends the information back to the network where the calculation is done. The accuracy of the position determined by using GPS is anywhere from 5 to 40 meters. A GPS uses a signal broadcast by a set of satellites. The major advantage of GPS is that it is a simple solution. There are currently single-chip solutions that include an entire GPS system. Assisted GPS or A-GPS, uses network receivers that are positioned in intervals of 200 to 400 km. The wireless network can then provide location information. A-GPS provides a more reliable location information service to the device. It also reduces the TTFF. Which can be in excess of 20-seconds? Differential GPS or D-GPS is similar to A-GPS in that the location information from GPS is improved by the network. D-GPS improves the performance of conventional GPS receivers and can be combined with A-GPS to increase the geolocation accuracy.

**c) GPS System of Satellites:**

The GPS system consists of a twenty-four satellites, orbiting the earth every twelve hours in groups of four following six separate orbits. These satellites transmit two signals once at 1575.42 MHz and other 1227.60 MHz. Commercial GPS devices use the signal broadcast on 1547.42 MHz. The signal being broadcast from the satellites includes a timestamp and the identity of the satellite that allows the GPS device to calculate distance to the satellite based on the time when the signal is received. The GPS device then uses triangulation of its distance to three or more satellites to calculate its location.

GPS Receivers:

There are various types of GPS receivers.

They are

1. Sequential Receivers
2. Continuous Receivers
3. Multiplex Receivers

Sequential Receivers receive a maximum of two signals at a time, looking for the signal coming from the different satellites in a sequential manner. These receivers have the slowest TTFF, typically between 20 and 45 seconds. Continuous receivers can receive signal from all of the satellites at the same time (more than there at a time because there is the minimum number of satellites needed to do triangulation). Continuous receiving gives us the best performance. Offering at least four receiving channels that can be operated simultaneously. Multiplex receivers cannot track as many satellites as continuous receivers

simultaneously. However, they can multiplex between the available channels and track more satellites than the sequential receivers. Thereby yielding performance that lies some where in between the sequential and continuous receivers.

#### IV. Non-GPS Location solution:

There are a variety of schemes and methods designed to discover the location of things without the usage of GPS. These methods range anywhere from radat systems to bange-based systems. Most of these positioning systems use the properties of the wireless networks for locating the devices that is using the wireless networks. Whereas GPS is the most robust method of obtaining location information to data. There are for some disadvantages in not using GPS based systems. First, the availability of GPS signals is not guaranteed. A GPS signal can be unreliable when inside buildings, where underground in bad whether or under any other circumstances. Like GPS based location solutions, some Non-GPS location solutions obtain the raw information on the device send it to the network for calculation of the actual location and get back the actual location if needed. Non-GPS based solutions are network-based solutions, which use the properties of an wireless network, MS-assisted network based (MS-stands for stations) solutions.

##### a) Cell-Identification Solutions:

**Cell-ID:** In this method, the serving cell identifier (cell-ID) is used to locate the user. The accuracy in this method depends upon the radius of the cell. For urban areas. E.g in a large city, this may be a few hundred meters in rural areas it could be up to 30 km.

##### b) Cell-ID Solutions:

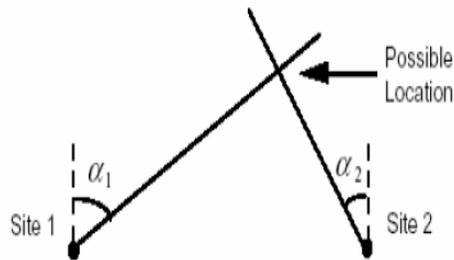
Cell-ID solutions are probably the most rudimentary way of obtaining the location of a device that uses a cellular wireless network as a method of wireless connectivity can be approximated by the absolute location of the cellular node to which it is connected. This can be enhanced with timing advanced (TA) measurement. TA is the measured time between the start of a radio frame and a data burst. The accuracy of this technique depends largely on the type of cellular network.

##### c) Cell-ID and Rxpower levels:

This information is used to locate the mobile subscriber with good accuracy and high speed. The mobile terminal gathers information concerning the serving cell and the power levels received from it. The network server calculates the position of the user based on the position of the cell-base stations and the power at which they are transmitting.

##### d) Angle of Arrival(AOA):

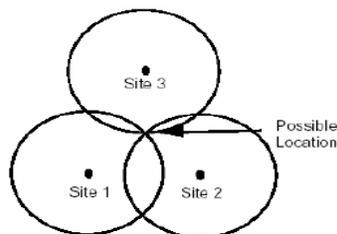
This requires a minimum of two basestations with directional autena. It measure the angle of arrival of signal, coming form a particular mobile subscriber at the two base stations and from this can calculate the user position.



Angle of Arrival

##### e) Time-of Arrival(TOA):

The time of Arrival method locate the mobile terminal by triangulation from a minimum of three base stations. Because the speed of electromagnetic waves is known it is possible to calculate the distance from each base station by observing the time taken to arrive.



Time-of Arrival

**f) Time of Arrival Solutions:**

One way of determining distance is to measure the time difference between when a signal is transmitted and when it is received. This distance can be used to calculate a rough geographical position based on the location of either the source or destination of the signal. Time-of-Arrival (TOA) solutions calculate the distance of a mobile device from a cell node based on the time it takes for a signal coming from the mobile device to the network cell node. As the cell node can also obtain the direction from which the signal is coming, it can calculate a distance and direction for the position of mobile device. There by calculation the position of the mobile device based on the position of the cell node that receives the signal. The accuracy of this method depends on the type of cellular network. TOA techniques provide an absolute location based on the relative location of the mobile user to the cell node whose absolute position is known. TOA has some advantages over cell-ID based techniques in offering somewhat more accurate location information for those cell networks. also, TOA techniques are more easily implemented in wireless network.

**g) Enhanced observed time difference(E-TOD):**

The enhanced observed time difference (E-TOD) method is similar to the TOA method in that the time it takes for the signal to travel is used to calculate distance. This time it is the time that it takes the signal to reach the mobile device from the source of signal. GPS is typically used to provide an absolute position for the source and absolute position of the source to calculate its absolute position. The accuracy of this method is roughly 125 meters. This method is really a hybrid of GPS and Non-GPS based techniques because GPS is typically used at the base stations to obtain absolute locations. E-TOD is an MS-assisted network-based solution.

**h) Wireless-LAN based Solutions:**

Short-range wireless networks such as Wi-Fi and Bluetooth have properties that can be used to determine the location of various nodes. The signal quality degrades quadratic ally proportional to distance. In the case of WLAN, this degradation is fairly significant. Large network can be composed of WLANs, So that the mobile devices can move through several networks without losing connectivity for a significant amount of time.

**Table(a) - Comparison of positioning technologies:**

Method	Coverage (Urban/Rural)	Accuracy	Cost
Cell-ID	Good/good	Cell radius	Server in network
Cell-ID-RxPower	Good/good	TBD (expected to be 30-200m)	Server in network; software on handset
GPS	Moderate/good	5-50m	Hardware in handset
A-GPS	Moderate/good	5-50m	Hardware in handset; reference receivers in network
Angle of Arrival	Good/moderate	50-300m	Directional Antennae and servers in network
Time of Arrival	Good/low	50-200m	Servers in network
Observed Time Difference on Arrival	Moderate/low	50-200m	Servers in network
Wi-Fi	Moderate/low	Expected to be 50-100m	Hardware in handset

**V. Hybridisation:**

The basic idea of the hybridization is to combine the position methods in such a way so as to fully exploit their strong points, compensate for the weaknesses, and provide the most appropriate and economical position solution according to the requirements set by the applications. The algorithm selects the appropriate technique based on the application scenario at the time the request is made.

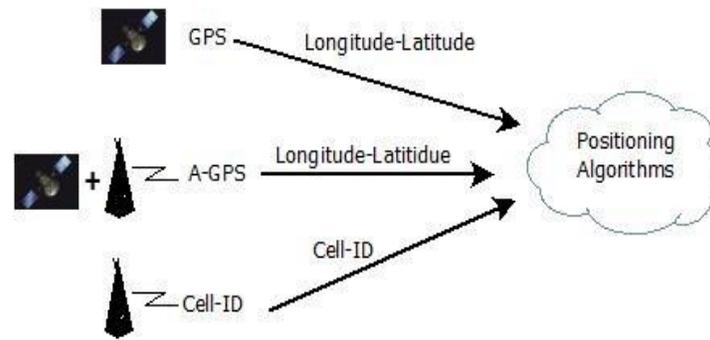


Fig: A high-level description of Hybrid positioning algorithm.

vi. Location Information Modeling:

Some methods for obtaining the location information as well as systems that allow us to cross reference useful information such as maps using the location information. To represent location-based data, we will look at the geographic markup language (GML).

- a) **GML:**GML is a XML based and its schema allows us to specific the types of positioning and navigational data. It is easily possible to use XML-based technologies to get a view of the location information. GML allows for both absolute and relative representation of location. This is done by allowing a client system representing from a server system that provides location-based services.GML gives a truly proper treatment to defining an extensible, flexible and scalable mechanism relative or symbolic measurement of spatial properties and locations. GML is a markup language designed to represent a model of location information.
- b) **NVML (Navigation Markup Language):** One of the most applicable areas of location-information in mobile applications involves helping users with navigational problems such as driving directions. Though navigation itself is a small subset of the location-based functionality that can be presented by a mobile application. It is an excellent example of location information to produce useful applications.

The major features of NVML are:

1. NVML provides a model for geographic navigation with route assistance and point guidance. Route assistance provides step-by-step help along the travel path.
2. Pont guidance provides information about things around a geographical point.
3. The Navigation element holds information about the starting and ending points of the route information about the route such as the distances and duration and other related information.
4. The guidance element holds information about the surrounding of geographic point.

- c) **MPP (Mobile Positioning Protocol):** The MPP is a protocol to be used to request and receive location information. This figure shows the general architecture for implementing mobile positioning using MPP.

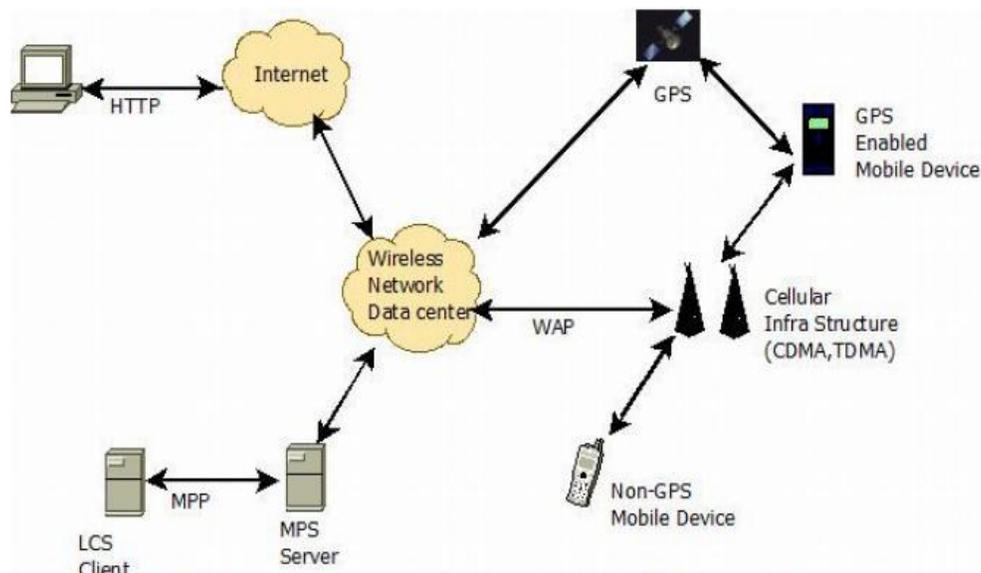


Fig: Using MPP and Supporting Architecture to provide Location information to Mobile Applications.

The mobile Devices that are GPS enabled can acquire location information directly from the GPS system. Those devices that are not GPS enabled have virtual one. We can have an MPP client on the device itself or implemented as a proxy on the network. MPP is request-response based.

**Using Location-Based Services with Mobile Applications:**

Mobile Location-Based Application
Application Program Interface(API)
Location Adaption Layer (LAL)
Location Dependent Layer(LDL)
Location Acquisition Hardware and Network(GPS, Non-GPS)

**Fig: Software Abstraction Layers for Developing Mobile Applications that use location information**

This figure shows type of abstraction as applied to mobile applications and their usage of location-based information. In practical terms, we can build a mobile application that takes advantage of location information under three conditions: when the device has some sort of access to an implementation of MPP (through WAP) then the device has a GPS until with the appropriate integrated software development tools, or when the device is enabled with sort-range wireless networking access such as Wi-Fi or Bluetooth.

vii. **Conclusion:**

This paper explains different techniques for locating a user mobile, and proposes an algorithm for hybridizing these methods, based on the user requirements. Therefore, location information facilities easier, better, and more localization and internationalization of other aspects of the mobile application such as the user interface.

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