LOCATION TECHNOLOGIES FOR GSM

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Location information is already widely used in the services in our daily life. Location Based Services are business and consumer services that give users a set of services starting from the geographic location of the client. These services offer the possibility to users or vehicles to find other persons, machines, vehicles, resources and also location-sensitive services, as well as the possibility for users to track their own location [1].

1 LOCATION TECHNOLOGIES

There are five main technologies in GSM Positioning Technologies:

- Cell ID + TA – network based solution
- Enhanced Observed Time Difference (E-OTD) – mobile station (MS) based solution
- Network Assisted GPS (AGPS) - MS based solution
- Angle Of Arrival (AOA) - network based solution
- Hybrid technology – MS or network based solution

There is defined mobile-based positioning as the case of the mobile station using the signals from the BTSs (Base Transceiver Station) to calculate its position. Cell coverage based location method is a network based approach, i.e., it does not require any new functionalities in the MS [2].

1.1 Cell ID + TA

It is the simplest way to describe the general location of a MS. It requires the network to identify the BTS to which the cell phone is communicating and the location of that BTS. Since the mobile station can be anywhere in the cell, the accuracy of this method depends on the cell size, since the typical GSM cell is anywhere between 2km to 20km in diameter. Further reducing the cell area by specifying cell sector is a typical strategy used to improve accuracy.

Positioning is generally more accurate in urban areas with a dense network of smaller cells than in rural areas where there are fewer base stations. If micro-cells are utilized, the cell size may be reduced significantly – to the range of several hundred meters. But these improvements may not be fully realized if the phone is operating in soft handoff mode, which introduces cell ambiguity.

Cell ID accuracy can be further enhanced by including a measure of TA. These measurements can be used to determine the distance from the MS to the BTS, further reducing the position error.

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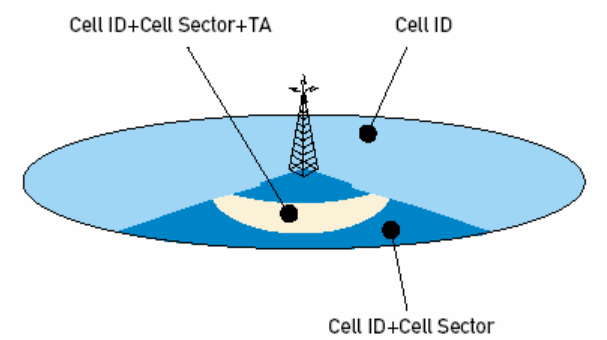

Figure 1: Cell ID + Cell Sector + TA [4]

1.2 Enhanced observed time difference (E-OTD)

The E-OTD positioning method is based on the MS measuring the arrival time difference between the bursts of nearby BTSs in GSM. The E-OTD requires modifications to the mobile station. The signals from at least three BTS units are received by a MS and also by a Location Measurement Unit (LMU). LMU is a reference receiver. The function of LMU is to calculate the difference of arrival time of signals from BTS by knowing the position of LMU. It measures same way as the mobile pilot signal timing differences from the base stations. From these timing differences and the known x, y coordinates the location server can easily calculate reference data for the E-OTD. The parameters of time differences of arrival of the signals is used when calculating the position of mobile terminals in location server. The Figure shows the principle of E-OTD method [3].

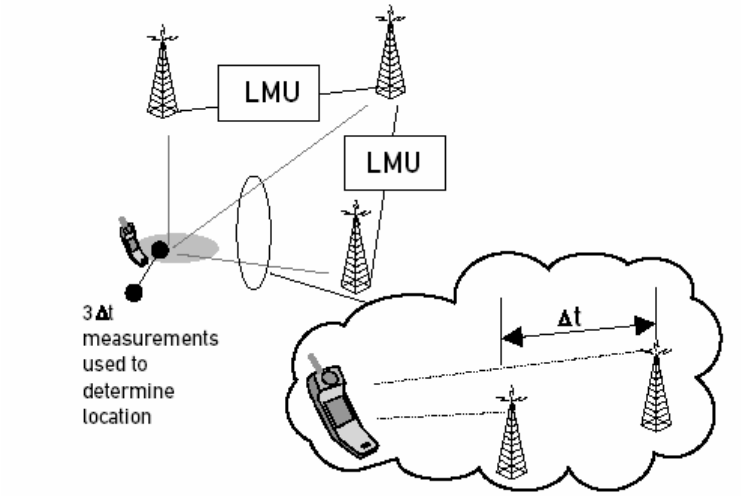

Figure 2: Enhanced observed time difference [4]

1.3 Network Assisted GPS (AGPS) or Wireless Assisted GPS (WAG)

A-GPS uses satellites in space as reference points to determine location. By accurately measuring the distance from three satellites, the receiver triangulates its position anywhere on earth. The receiver measures distance by measuring the time required for the signal to travel from the satellite to the receiver. This requires precise time information, so in practice, measurements from a fourth satellite are required to help resolve time measurement errors created by the inaccuracies of inexpensive timing circuits typically used in MS.

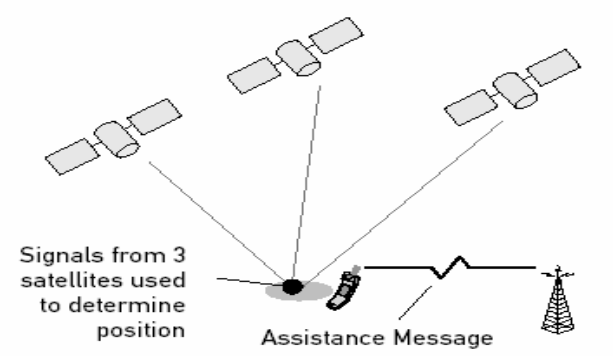

Figure 3: Network assisted GPS [4]

1.4 Angle Of Arrival (AOA)

Angle of Arrival methods are based on the assumption that BTSs can measure the angles of arrival of signals transmitted by the MS. If there were Line Of Sight (LOS) between the MS and two BTSs and AOA measurements were available, the MS would be in the intersection of the lines defined by angles of arrival. Multipath causes severe errors, especially when AOA methods are used in urban environments. This method requires that BTSs are equipped with antennas that can measure AOA values.

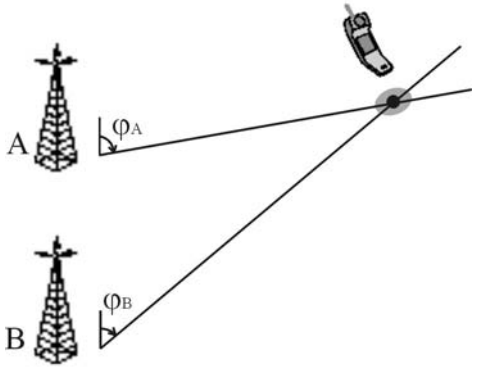

Figure 4: Angle of arrival

1.5 Hybrid technology

Hybrid location technology combines A-GPS with other location positioning in a way that allows the strengths of one to compensate for the weaknesses of the other to provide a more reliable and robust location solution. The most common implementation of Hybrid technology for GSM is to combine A-GPS with Cell-ID. Typically, these are areas where cell density is high, so Cell-ID will be at the more accurate end of its accuracy range, though it will not be as accurate as A-GPS.

A-GPS	+	Cell-ID	=	Hybrid
High accuracy		Poor accuracy		High accuracy
Good yield		High yield		High yield

Figure 5: Hybrid operation

	Accuracy	Commercial availability on GSM	TTTF - Time To First Fix	Network upgrade cost	Handset cost increase
Cell-ID+TA	150 m - 30 km	1999	<10 s	Minimal	Nil
E-OTD	50 - 150 m	2000	<10 s	Medium	Nil
AGPS	3 - 50 m	2002	10 s to 1 min	Medium	Very High
AOA	Unlikely to achieve 150 m	2002 non-standards	<10 s	High	Nil
HYBRID	3 - 100 m	2002	<10 s	Medium	Very High

Figure 6: Comparison location technologies

2 LOCATION BASED SERVICES - LBS

The location based service applications can be categorized as:

Navigation applications
- Route description, Turn-by-turn navigation
- Dynamic route guidance with maps

Safety and emergency applications
- Emergency calls, Breakdown services
- Warning about unsafe areas
- Nearest medic centre & doctor

Tracking applications
- Find a friend, Fleet management
- Asset tracking, e.g. cargo
- Tracing of stolen property/ vehicles, Person surveillance

Information service applications
- Yellow pages, Traffic information
- City Guide, Parking, Maps

Operator & Tariff applications
- Home Zone, Tariff Zone
- Traffic measurements
- Network planning [3]

References:

[1] – GSM Association, „Location based service“ version 3.0.0, February 2002
[2] – Christopher Drane, Malcolm Macnaughtan, Craig Scott „Positioning GSM telephones” – University of Technology Sydney, April 1998
[3] - Hongying Yin, „Location based service“ - T-109.551 Research Seminar on Telecommunications Business II, Helsinki University of Technology, March 26th 2002
[4] - SnapTrack, A QUALCOMM Company - Location technologies for GSM, GPRS and WCDMA networks, September 2001

Summary: *In diesem Beitrag habe ich mich mit den verschiedenen Lokalisierungsmethoden befasst, die man bei der Lokalisierung der Mobilnetzen nicht nur in GSM ausnützt, sondern auch in anderen Mobilnetzen. Ich habe fünf Lokalisierungsmethoden analysiert, die für GSM positioning die wichtigste sind.*

Heutzutage führen die Mobiloperatoren die Dienste auf dem Markt ein, die direkt mit dem Standort des Anwenders im Netz zusammenhängen. Heutzutage händelt sich besonders um AGPS. Diese Methode ist für den slowakische Anwender zu teuer, weil sie GPS ausnützt. Aus diesem Grund ist entsprechend die Methoden auf der Base GSM zu benützten.