

## GSM-based positioning: techniques and application

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**Abstract.** This dissertation reports on the opportunities for GSM-based positioning techniques anno 2008. Practically, this means that both the typical structure of dense (sub)urban networks and the possibilities of modern handsets are taken into account. The potential of the techniques under study is every time evaluated for the stringent demands of the upcoming generation of location-based services (LBS). Though privacy issues are not explicitly dealt with, it is noteworthy that all developed techniques focus on a terminal-based implementation. This means that a user keeps full control over his position information.

The upcoming generation of LBS is mainly characterized by three properties: they are proactive, operate in a multi-user context and use cross-referenced position information. This rather agile environment makes that – besides accuracy – other requirements on the positioning technologies gain importance. Energy use should be kept low (due to battery limitations), start-up times should be short (fostering hibernation strategies), and the availability should be as close as possible to 100%. These are three aspects where GSM-based techniques offer a competitive advantage compared to GPS, which is currently the most-applied technique.

First the possibilities of Cell-ID positioning, where the position of a user is deducted from the antenna to which the mobile is connected, are studied. Both a holistic accuracy study (for Belgium) and a feasibility study for an urban application are provided.

Next, a series of dynamic algorithms that switches between GPS and Cell-ID positioning is developed for a multi-user position tracking context. The different algorithms are compared using simulations and the working principles of this multi-technology approach were verified through a proof-of-concept in the city of Munich.

In the last part of the thesis, it is shown how the typical structure of (sub)urban GSM networks – the so-called clover-leaf structure, where each mast contains three antennas – can be exploited for positioning. By treating the Received Signal Strength (RSS) measurements from the same mast location differentially, it is possible to obtain an angle estimate. It is also possible to construct a displacement detector by combining RSS information with the Common Base Station indicator. Both approaches were verified using measurement of the GSM network in the city of Brussels.

This work shows that GSM-based positioning techniques – especially in a terminal-based implementation – have their use within a context of location-based services. Though the accuracy will never reach the sharp precision of GPS, GSM techniques have other properties (availability, low power use) that make them attractive again. This has as a consequence that application designers will have to keep in mind a multi-technology environment when designing the next generation of LBS applications and middleware.

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