



Vrije Universiteit Brussel

GSM-based Positioning: Techniques and Application

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VUBPRESS

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Print: DCL Print & Sign, Zelzate

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© 2008 Uitgeverij VUBPRESS Brussels University Press
VUBPRESS is an imprint of ASP nv (Academic and Scientific Publishers nv)
Ravensteingalerij 28
B-1000 Brussels
Tel. ++32 (0)2 289 26 50
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E-mail: info@vubpress.be
www.vubpress.be

ISBN 978 90 5487 494 2
NUR 959
Legal deposit D/2008/11.161/038

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3.3. Cell-ID positioning

means that the position of a terminal in Dedicated mode is even known on a cell basis.

The position of a terminal that has been switched off is evidently unknown to the network. In case the battery ran empty (or was suddenly removed), the network will assume that the terminal still resides in the same LA, until a lack of periodic location updates gets noticed. When the terminal was switched off correctly, the network receives a detachment message and assumes that the terminal is not reachable until a new location update arrives.

3.2.3.4. Why mobility management and positioning are different

The goal of mobility management is to deal with the mobility aspects of the terminals. Mobility management addresses and solves the problem of "how to reach a terminal". This is inherently different from positioning, where obtaining the geographical location of a terminal with sufficient accuracy is the main goal. The remainder of this chapter will deal with positioning aspects.

3.3. Cell-ID positioning

With the term "Cell-ID positioning" we mean – in this thesis – that the position of a terminal is deduced from the cell it is connected to. This mechanism is called proximity sensing: the position of an object is derived from the position of the serving base station. Or put in simpler wording: there exists a mapping function between each cell identifier and geographical information. This section first elaborates on the construction of the cell identifier, after which we consider the different possibilities for geographical mapping.

3.3.1. Cell identifier

In GSM standards, the unique identifier of a GSM cell is called the *Cell Global Identity* (CGI). It consists of four elements (see figure 3.6): the *Mobile Country Code* (e.g. 206 for Belgium) followed by the *Mobile Network Code* (e.g. 01 for Proximus, 10 for Mobistar and 20 for Base), the *Location Area Code* and the *Cell Identifier*.

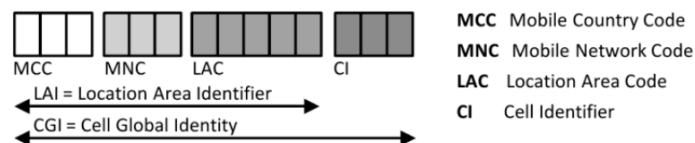


Figure 3.6.: Structure of the identifiers for mobility management

3. GSM Cell-ID positioning

The scenarios described in this thesis typically make use of only one network, and there is no need to distinguish between the different location areas. Therefore the term *Cell-ID* will be used – to avoid confusion – simply denoting the unique identifier of a cell.

When consulting technical literature, care must be taken as many terms are (sometimes mistakenly) used interchangeably. Common names are *Cell of Origin* (CoO), *Cell Global Identity* (CGI), *CID*, or *CI*. In most cases, these terms are used to describe what we have named Cell-ID in this thesis: a unique identifier for a cell.

3.3.2. Situation overview

Figure 3.7 shows a map of the surroundings of the Vrije Universiteit Brussel, representative for a typical European urban environment. Most of the test measurements of chapter 5 were made in this area. There are five base station locations visible on the map (the dots with the cryptic³ three letter codes). Each base station location has three sectorized antennas (the so-called clover-leaf configuration). Each antenna serves a cell that covers an area of about 120° from the mast. The horizontal antenna orientations (called azimuth) are the same for all five locations: 60°, 180° and 300°. This is a common approach for network planners, as it results in a semi-regular network structure, which facilitates the frequency reuse planning. Each of the individual cells has a different shape, a feature which has many reasons. The antenna gain pattern and terrain and building profiles play certainly a role in it, but the dominant factor that determines the cell shapes is the distance between the different antenna sites.

A GSM network Γ consists of N_Γ disjunct cells $C_1, \dots, C_{N_\Gamma}$. Assume a terminal m , located at a position $p_m = [x_m, y_m]^T$, with x_m and y_m being the coordinates of the position. If m is connected to the network Γ , it will always reside in one of the cells:

$$\forall m \quad \exists! i \in \{1, \dots, N_\Gamma\} : p_m \in C_i \quad (3.1)$$

Cell-ID positioning deals with the question of how the maximum of information can be taken out of the statement $m \in C_i$ so that the position of the terminal p_m can be estimated with the highest possible accuracy, together with an upper bound on the estimation error.

3.3.3. Geographic mapping

Two different approaches to Cell-ID information will be discussed in this section: *mapping to a point* and *mapping to an area*. In both cases we shall explain how the accuracy can be correctly assessed.

³ These and alike labels are commonly used by MNOs, as they provide a mnemonic aid for remembering where a certain antenna is located, e.g. ETS is "Etterbeek Station" and INV stands for "Invalidenlaan".