Chapter XI
Mobile Positioning in Next Generation Networks

Peter Brida
University of Zilina, Slovakia

Peter Cepel
Siemens PSE s.r.o., Zilina, Slovakia

Jan Duha
University of Zilina, Slovakia

ABSTRACT

This chapter deals with mobile positioning in wireless heterogeneous next generation networks. Positioning process is analyzed and the chapter gives an overview of the basic positioning principles and methods that can be used in various NGN platforms. The main focus is given on cellular, ad hoc and sensor networks. Fundamental positioning methods are similar regardless of network platform. The difference usually lies in positioning accuracy. This is caused by technical parameters of the particular application platform. The end of the chapter deals with positioning experiments. The main purpose of authors is simple explanation of fundamental positioning principles for various NGN network platforms.

INTRODUCTION

Mobile positioning is a broad topic that has received considerable attention from the research community over the past few decades. There is increasing interest towards positioning technologies and Location Based Services (LBS), but the utilization of mobile positioning in emergency situations and LBS are not alone. The mobile device position information will play an important role in radio resource management algorithms. Positioning in wireless ad hoc and sensor networks is important in term of routing algorithms and effective communication between particular network elements. Application of ad hoc networks is not only in security services but also in location based applications. Ability to define mobile device position depends on accurate positioning data achieving. This information is used to calculate the mobile device position. The data capturing is realized by measuring
particular parameters of the radio signal. Measurements relate either explicitly or implicitly the mobile device position to the position of reference devices or to the specific behavior of the mobile device and its surrounding environment. Each measurement defines a line of position and the mobile device lies on this line. The mobile device position can be calculated by the intersection computation of measured lines of position.

Mobility of the mobile devices is high and there is usually no restriction regarding the mobile device environment. It is necessary to differentiate indoor and outdoor positioning environment and to choose correct positioning technology on the base of corresponding environment. The most accurate positioning results can be obtained by means of GNSS based positioning, but this system is applicable only in outdoor environment. Indoor environment requires the different positioning technologies, e.g. cellular, ad hoc, sensor or RFID positioning.

Generally, we can say that the application of positioning system needs to take into consideration two basic factors: the positioning accuracy and deployment costs. These factors may be opposite, but they are important for successful positioning based solution.

POSITIONING IN WIRELESS NETWORKS

The concept of positioning is not limited just to the geographic representation of physical location with sets of coordinates (latitude, longitude, and altitude). It is also applicable to symbolic location in a non-geographic sense, such as location in time or in a virtual information space, such as a data structure or the graph of a network.

Common to all notions of location is the concept that the individual locations are all relative to each other, meaning that they depend on a predefined frame of reference. This leads to a differentiation of the relative and absolute positioning (Tseng, Huang & Kuo, 2005).

If position information is used in reference to a geographic map or a global time reference, the context information can be extended. An absolute position is given with respect to an inertial system and a reference point in the inertial system. On the other side, a relative position can only be given with respect to other points resolving the distances and the geometric configuration, e.g., the topology.

When talking about physical location in the traditional way, points are usually viewed as three-dimensional coordinates \([x; y; z]\) in a Cartesian reference coordinate system.

Usually, \([x; y; z]\) coordinates by themselves are not meaningful for context-aware system services and the other information needs to be associated with this position information. In these cases, it is important to introduce the fourth dimension – time. If a time dimension is introduced, we are able to specify where and when a certain event took place resulting in sets of \([x; y; z; t]\) for each position information. The four-dimensional fix can be used to put subsequent events into a context frame.

Positioning Methods Classification

There are numerous methods that can be considered for implementation in wireless position location systems. We will discuss the most often used methods. It is possible to define many criterions for separation of the particular methods.

One viewpoint of examining positioning methods is to consider where the position measurements are made and where the position information is used for position estimation. There are two basic positioning groups: mobile based positioning and network based positioning.

In a mobile based positioning (self positioning in (Drane, 1998) or mobile centric in (Klukas, 1997)) method the receiver (localized mobile device) makes the appropriate signal measurements from geographically distributed transmitters (reference devices, e.g., base stations, reference nodes). These measurements are used to determine receiver location. Computing operations are done in mobile device, e.g. Mobile Station (MS). The best known mobile based positioning system is Global Positioning System (GPS). MS knows its position, and the applications collocated with the MS can use this information to make position based decisions. This position information can be also sent to another system, e.g., monitoring centre.

In a network based positioning (remote positioning or network centric) method, receivers (reference devices) at one or more locations measure a signal originating from the positioned device. These measurements are com-