Integration of Indoor Positioning into a Global Location Platform

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Motivation

Seamless service provisioning, moving between outdoor and indoor environments requires a complex interaction between the different positioning systems e.g. outdoor cellular/GPS to indoor WLAN/Bluetooth Positioning Systems. There are…

...many different Positioning schemes depending on underlying Networks e.g. GPS, GSM/UMTS and Methods e.g. Cell Of Origin, Triangulation, Signal Strength Finger Prints etc.

...many Location Architectures e.g. Polos Architecture (www.polos.org), Cello Project (http://www.telecom.ece.ntua.gr/cello/) and Products e.g. Microsoft MapPoint, Siemens LES v2.0, Ekahau Positioning Engine v2.1 etc.

Goal: An “open” homogeneous Location Architecture providing the “best possible” position information of a mobile device.

Positioning Techniques Implemented

<table>
<thead>
<tr>
<th>Positioning Method</th>
<th>Technique</th>
<th># of Access Points</th>
<th>Achieved Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell-Of-Origin</td>
<td>Uses ESSID of Access Point where client is currently registered (via MAC Address)</td>
<td>1</td>
<td>10-25m</td>
</tr>
<tr>
<td>Triangulation (by Signal Strength)</td>
<td>Measured Signal Strength of Neighboring Access Points, finds distance using “Path-Loss” Calculations</td>
<td>Min. 3</td>
<td>5m</td>
</tr>
<tr>
<td>Finger Print Method</td>
<td>Matches measured signal strength against signal profiles (e.g. room, halls) generated during initialization phase</td>
<td>3-4</td>
<td>1-2m</td>
</tr>
</tbody>
</table>

Reducing Measurement Error by Geodetic Measurement Methods

Geodetic Transformations realize the integration of a local Transformation of local coordinate System used in the WLAN Positioning System into a global reference frame (WGS84), such as used by GPS.

Furthermore, the reflectorless distance measurement allows for a dense test environment, which determines the position of the WLAN card (hence the user) and of the access points itself within a few millimeters, hence reducing the initial positioning error during the training period.

Architecture

During the tests at CDTM, using three Access Points, 177 measurement points within 152 square meters were recorded with a time exposure of seven man hours (Figure B). To reduce the initiation time for the finger print method, we experimented with cubic interpolation algorithm. Figure C shows the results of our measurements and the interpolation results. With only 10% of the measured signal strengths we could show that the finger print method is still working.

Conclusion and Outlook

Our aim is to realize a homogenous positioning platform for different network types in different environments (i.e. indoor and outdoor) and to offer service providers the best available localization. By providing a generic interface independent from the actual used positioning technique developer are able to create location-based services without thinking about integration problems.

Future Steps are:

- Reducing Initialization Period of Positioning Systems
- Inter-Technology Positioning Handoff for Seamless Location Provisioning: (outdoor/GSMÆ Indoor/WLANÆ outdoor/GPS)
- Multiple Positioning Sources for Increased Positioning Accuracy Support.
- Location Signaling and Billing in Heterogeneous Networks