

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 natured 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.

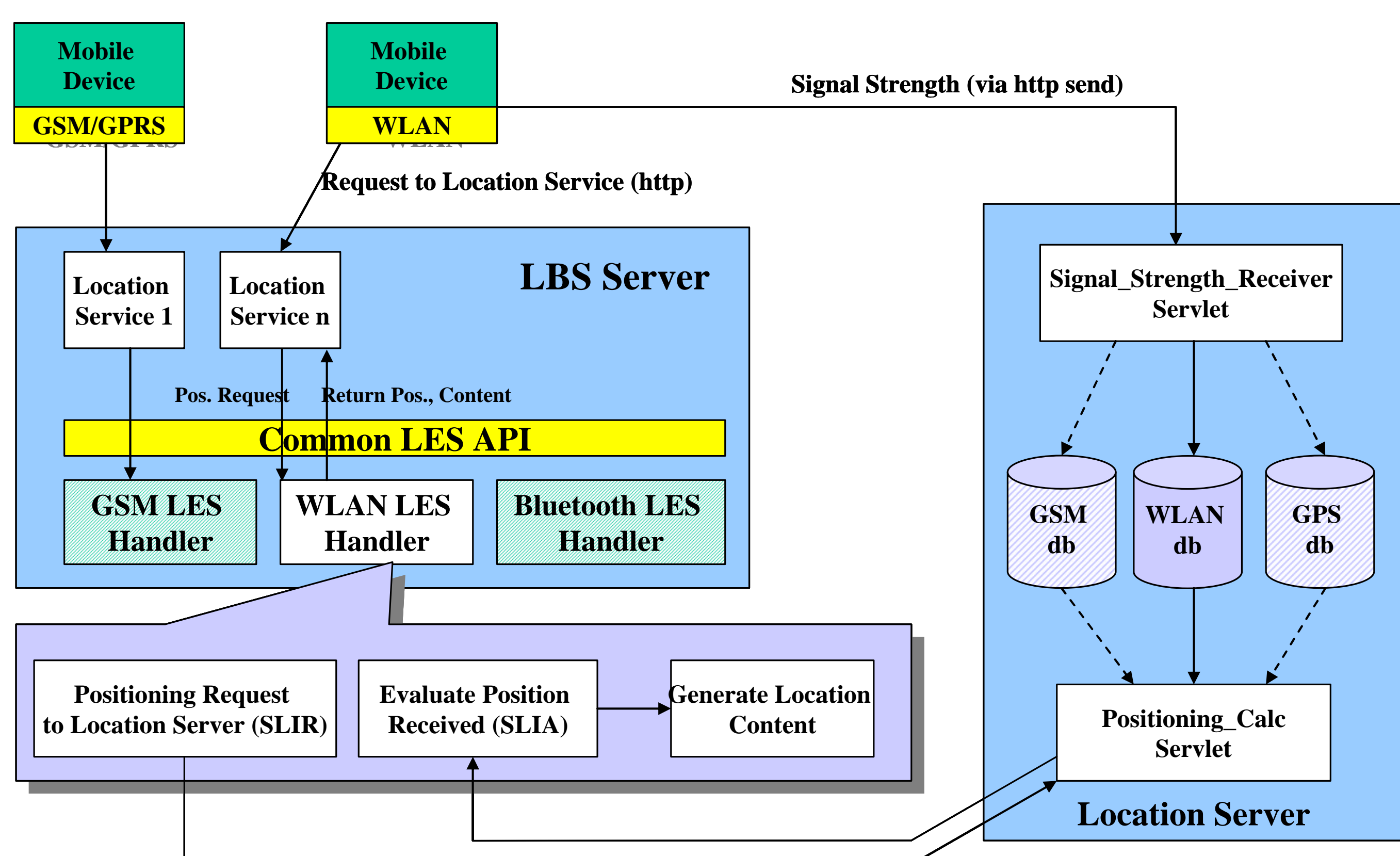
...many **Location Architectures** e.g. PoloS Architecture (www.polos.org), Cello Project (<http://www.telecom.ece.ntua.gr/cello/>) and **Products** e.g. Microsoft MapPoint, Siemens LES v2.0, Ekahau Positioning Engine v2.1 etc.

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

Positioning Techniques Implemented

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

Architecture

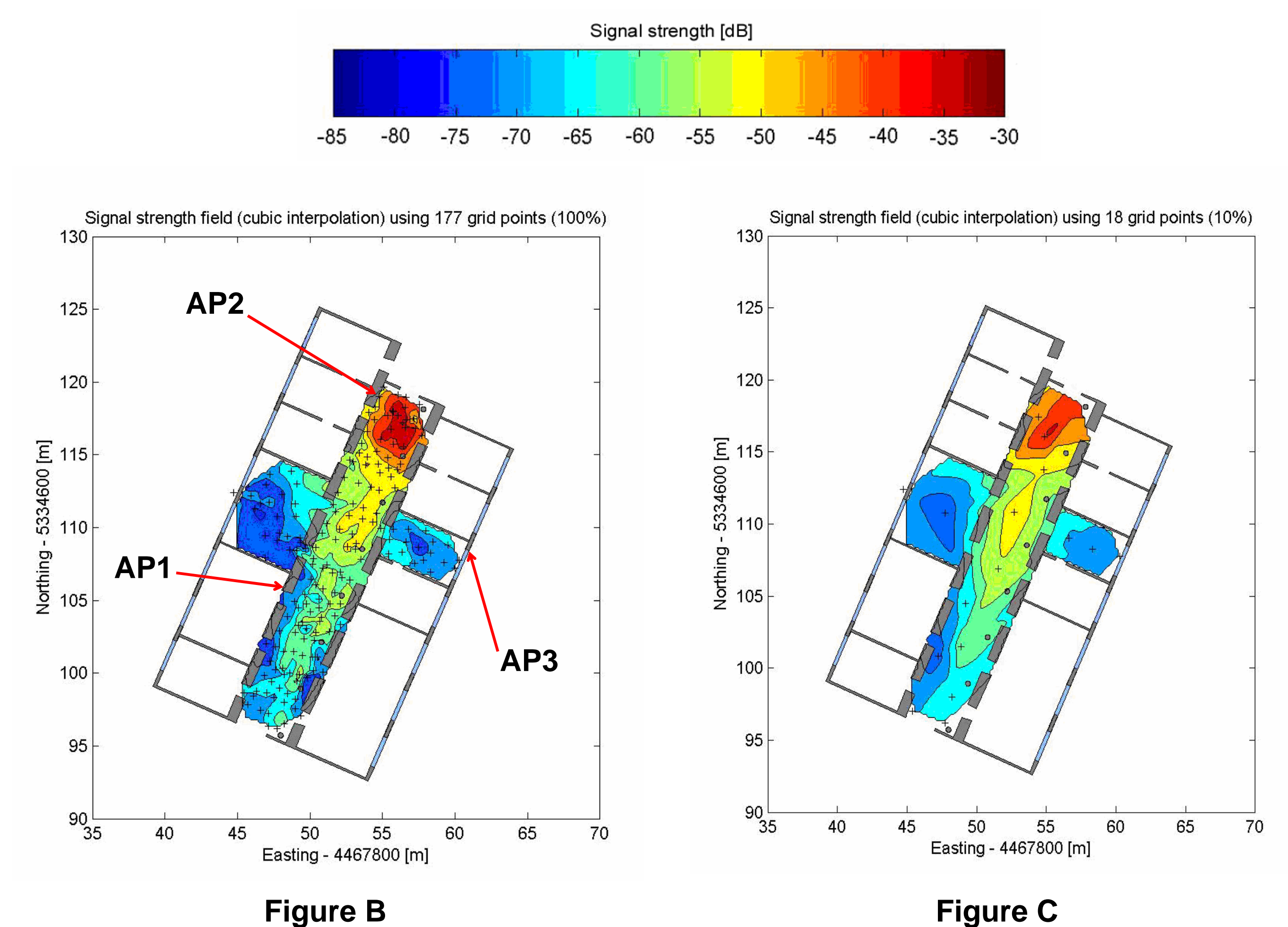


- Common LES API modeled after Siemens LES v2.0 API2 (provides high level functions such as position, route, navigate, find nearest POI)
- Lower LES Handlers provide Access Technology Network Specific Positioning Information and evaluate positioning Accuracy required vs. available

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.



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/GSM → indoor/WLAN → outdoor/GPS)
- **Multiple Positioning Sources** for Increased Positioning Accuracy Support.
- **Location Signaling** and **Billing** in Heterogeneous Networks