

INDOOR POSITIONING

The topic of asset tracking and applications that need indoor positioning has been hot for almost a decade. The real breakthrough is yet to come but applications and systems are slowly expanding

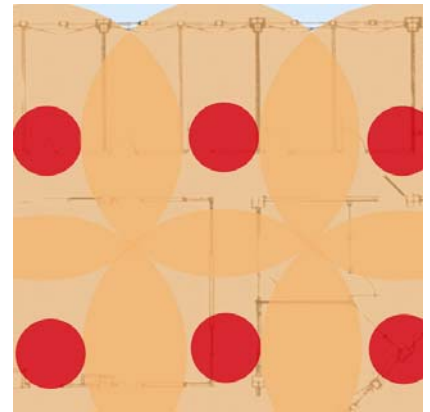
Let's have look at the different methods and technologies.

There are basically four methods:

- Base station positioning
- Sign post positioning
- Field strength positioning
- Time delay positioning

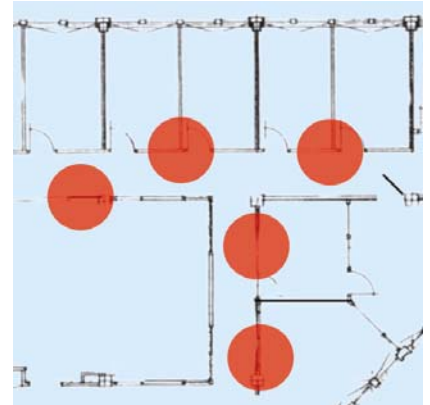
Base station positioning

This is the simplest and normally least accurate method. It only works with micro cellular indoor systems (with many base stations) like WiFi and DECT. The position is given as a radius around the current radio base the device is connected to, typically 15-30 m. Although a very simple method, some consideration must be given to the handover algorithm. In normal operation a handset is not always connected to the closest base and in order to increase accuracy the handset must scan the radio environment more often and always chose the closest base. This will increase power consumption!



Sign post positioning

This is a more generic method and is not depending on a specific radio infrastructure. The method is based on measuring the passage of a certain point, a "sign post". This point is equipped with a radio or IR transmitter with a short range, typically 1-3 m. When the positioned device passes such a sign post the position and in many cases the time is stored in the device. Depending on the application the position can be immediately transmitted to a location server or the position is only used when triggered by an event, for example by an alarm.



Field strength positioning

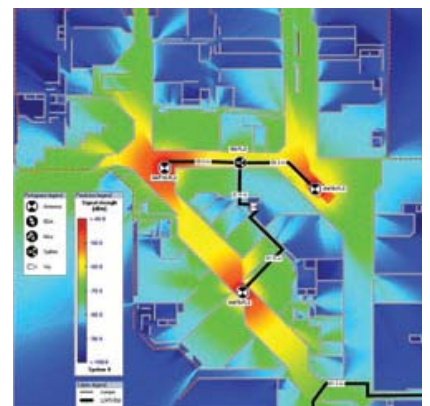
The third method is again using the micro cellular radio infrastructure and is mostly used with WiFi but can theoretically also be used with DECT.

The field strength pattern (radio signal strength) can be calculated if the floor plan of a building is known and material parameters of floor/wall/ceiling can be estimated. A model of expected field strength can be shown on a "heat map".

The accuracy of this simulation can be improved by calibrating known positions with real measurements.

There are two system topologies that can be used:

- Device centric – meaning that the device (a phone or a positioning tag) measures the field strength from all radio bases that can be received. These measurements are then sent to a positioning server that estimates the position by comparing the measured values with the model.
- Infrastructure centric systems are also comparing measured values with a model but in this case it's the base station that reports the field strengths of the mobile devices. The positioning server is then estimating a position.



Time Delay positioning

This technology is very similar to the well known GPS methodology. The times of arrival for very short pulses are measured and the distance to the transmitter can be calculated. With several transmitters spread over an area the position can be calculated by means of geometric triangulation. This works well in open free field situations, but indoor the signal from a transmitter can be reflected several times and the time of arrival can be rather complicated to detect. The accuracy is also depending on the pulse width and generally requires rather wide bandwidth which can be a problem with several coexisting radio applications.

Accuracy

Which of the above mentioned methods/technologies is the best? Well, as always the answer is, it depends... As with all radio based systems there is no bullet proof solution and it's important to understand the application for which the positioning system is used.

Base station positioning is rather simple and robust and can be accurate enough for a single floor building giving typically zones of 15-30 meters radius. It suits both DECT and WiFi but is not applicable for paging since the radius from one base is too large.

Sign post positioning is only giving discrete positions but with high accuracy (1-3 m). This is the most generic of all methods but it requires a dedicated infrastructure with sign post beacons and the portable must be equipped with receivers to receive the beacon signals.

A sign post system is probably the most reliable when it comes to ensure correct floor positioning in multi stories buildings and by placing beacons on either side of a doorway, direction can also be detected.

Field strength positioning gives apparent real time positions and can be surprisingly accurate under certain conditions (1-3m). One challenge with field strength positioning is that the calibration can be rather time consuming either by real measurements or by accurate simulation of building floor plan and building material properties. But the biggest problem comes from the changing of radio properties by opening and closing heavy doors, empty or full shelves in warehouses or large object moving in production areas. Positioning of portables that are carried by human beings is also affected by the human body that acts as a pretty good RF absorber and the position can be apparently changing just by rotation of the body. Taking these real factors into consideration the accuracy deteriorates to ~10 m. One interesting observation is that field strength positioning indoor is most accurate in older buildings with very thick walls. This can seem as a contradiction but the field strength is more stable since the building is contributing to the biggest variation and the fluctuation from humans and other changing factors are less influencing.

Time delay positioning is mostly used for outdoors applications and with the increased accuracy and low cost of GPS receivers, this technology will probably loose importance in the future

Ascom solutions

Positioning has been a feature in our different systems for almost two decades. Today we have IR, LF and DECT as sign post technologies. DECT and WiFi use Radio base positioning and our I75 WiFi phone is working in Field strength positioning systems.

The Unique DECT beacon technology eliminates the need for a dedicated beacon receiver in our DECT handsets.