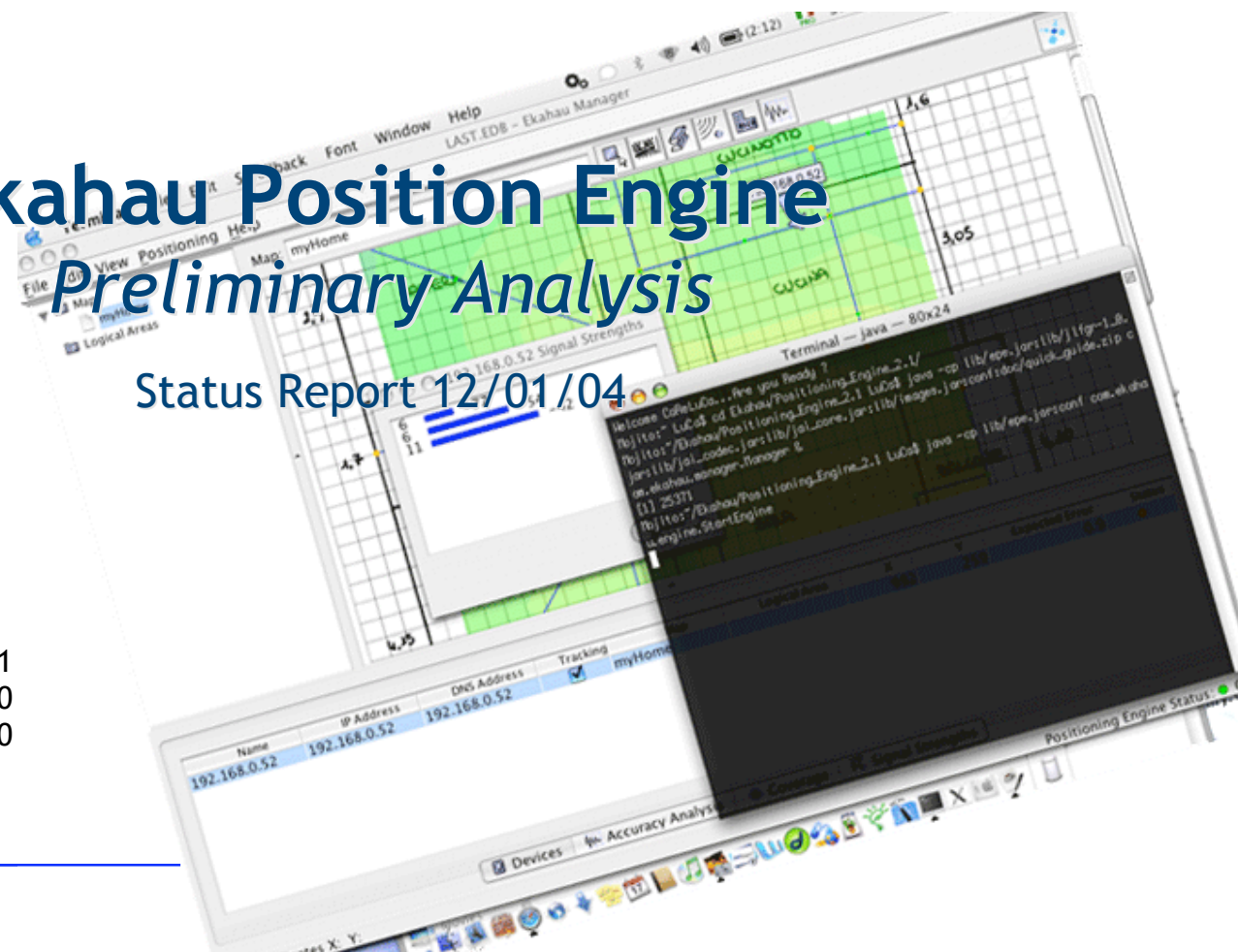


Ekahau Position Engine *Preliminary Analysis*

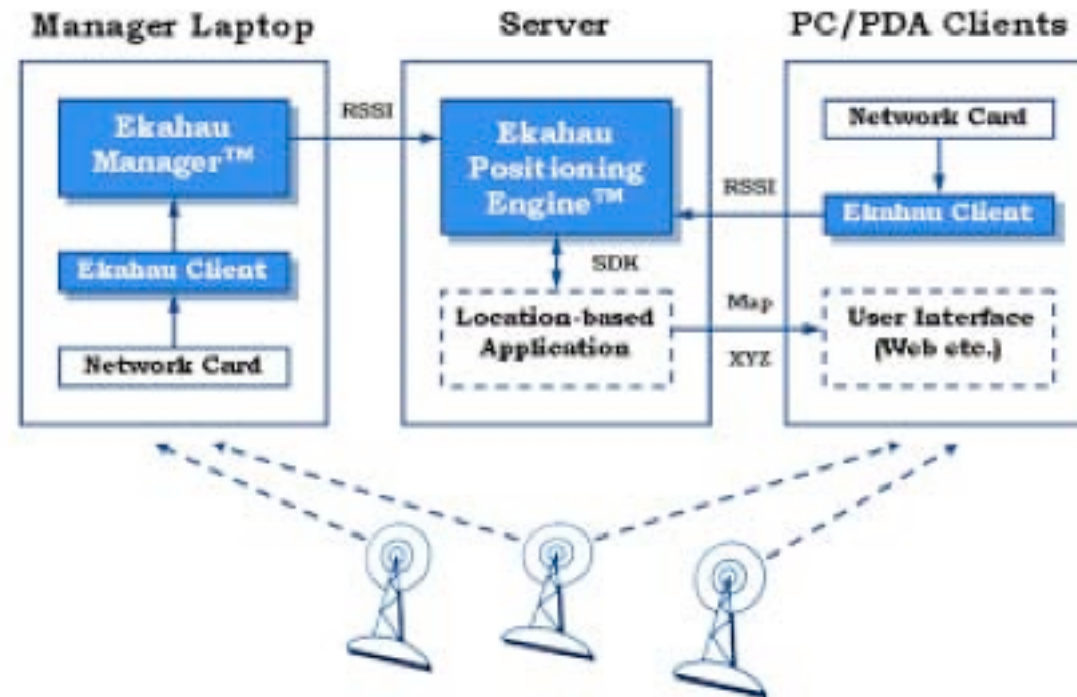
Status Report 12/01/04

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Ekahau: Software Architecture



The positioning software Ekahau is composed to:

- ✓ Ekahau Position Engine (EPE 2.1)
- ✓ Ekahau Manager
- ✓ Ekahau Client (3.0)

Ekahau Position Engine 2.1 + Manager

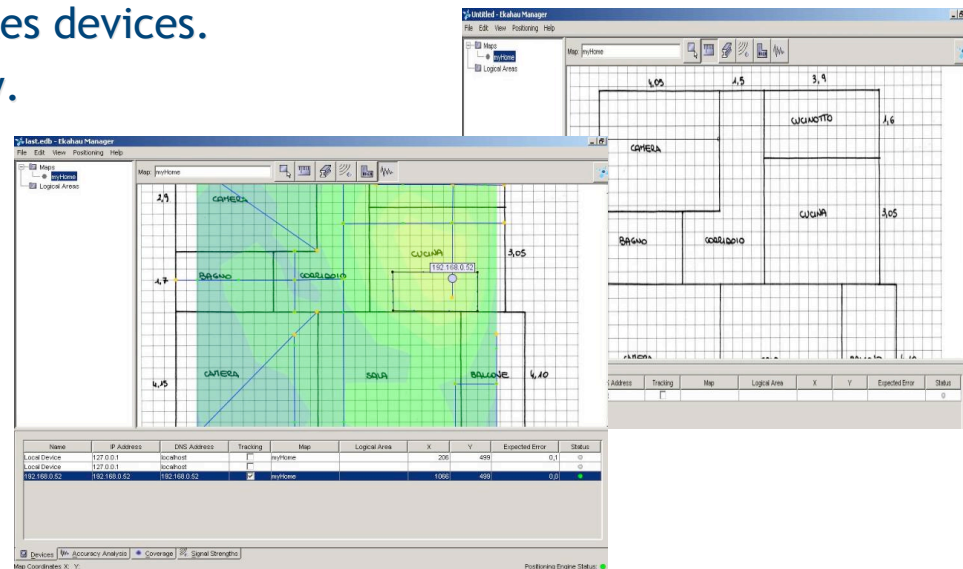


Engine: Java based software that provides server functionality to localized device with wifi protocol (802.11b).

Manager: Java based application that supplies the possibility to use engine functionality with a comfortable graphic interface.

With Ekahau Manager you can:

- ✓ Create e Manage positioning model, defining on they logical areas.
- ✓ Trace the position of associates devices.
- ✓ Analyze the position accuracy.



Ekahau Client 3.0



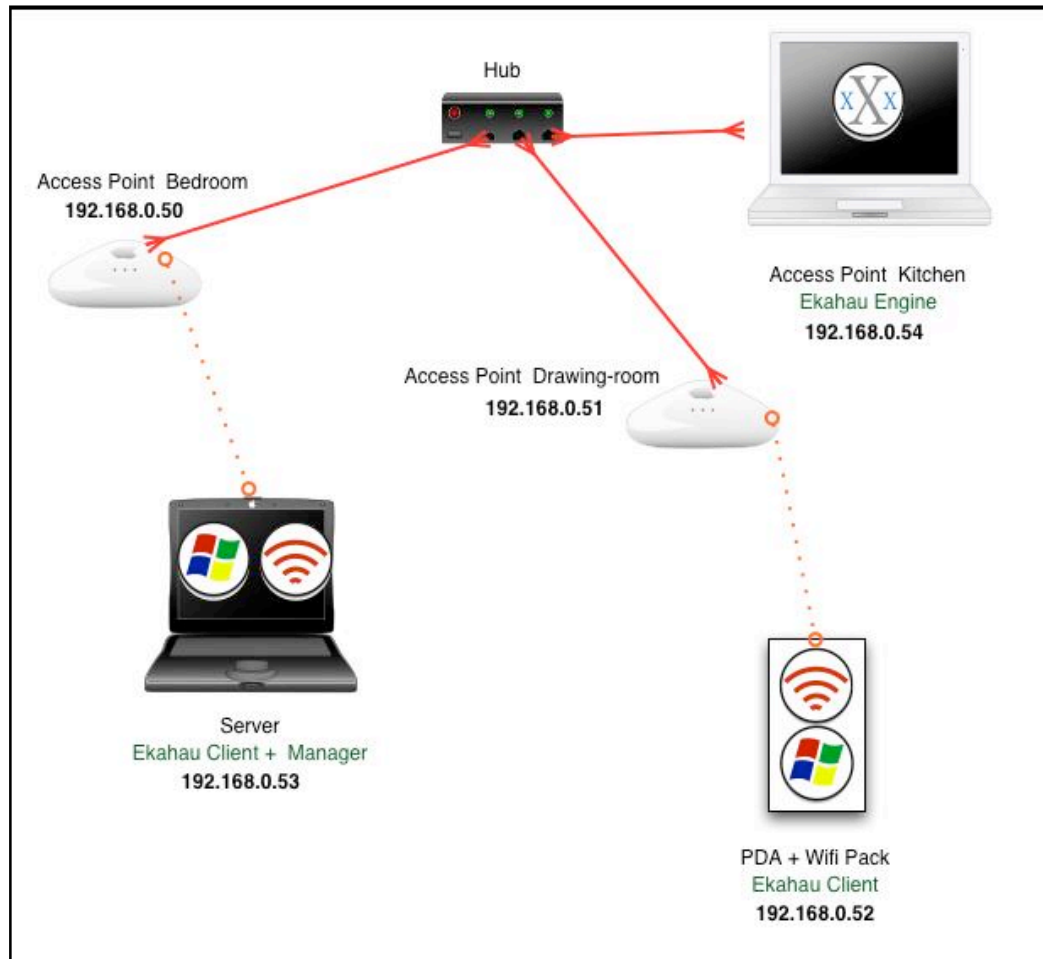
This software component allows the analysis of the Access Point signal power (which AP compose the net infrastructure) and provides to EPE the information about network necessary to localization.

This software is developed only for Windows platform (WinXP, Win2K, Windows CE 3.0 e PocketPC 2002) and it demands a specific wifi network card supported by software.

For more info about Wifi Network Cards compatibility refers to official website:
http://www.ekahau.com/products/client/ReleaseNotes3_0.html



Hardware used during the test



- 2 AP D-Link DWL-2000AP (802.11b/g)
- 1 Apple Powerbook used like AP (802.11b/g)
- Hub 4 porte 10/100 Netgear
- 1 notebook Dell with wifi network card Netgear WG511 (802.11b/g)
- 1 Compaq Ipaq with pcmcia extension-pack and wifi network card Avaya Gold (Orinoco chipset)

Hardware Configuration



- During the creation phase of the positioning model, We have found some problem related to the support of the wifi network card Netgear because it isn't completely compatible with Ekahau software, supplying wrong values of APs power signal.

Therefore we have adopted two different configuration:

- *Mapping phase:*

-Dell notebook has been equipped with Avaya wifi card because during this crucial phase is indispensable have on the same device, the client and the manager applications.

- *Tracking phase:*

We have used the same configuration like the previous schema.

In this phase is only necessary that the devices you which must be traced are equips with wifi card “FULLY” supported.

Software configuration



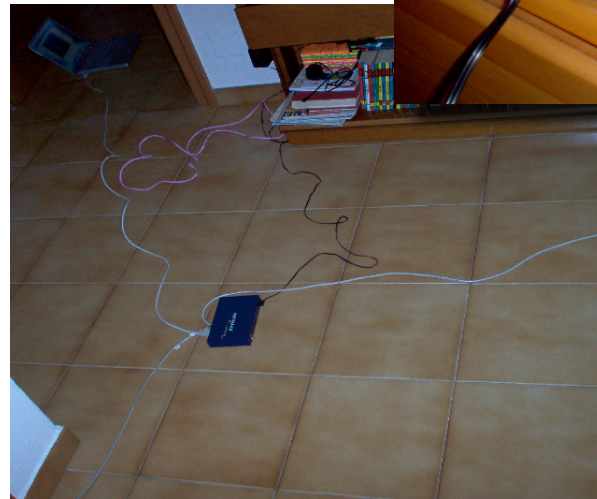
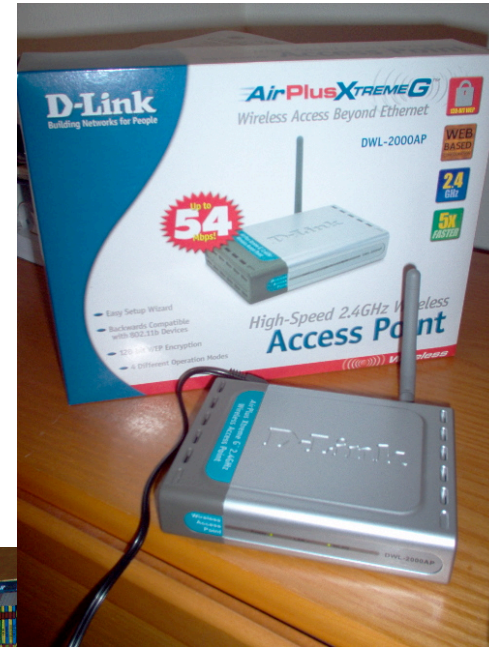
- Ekahau Position Engine
 - ✓ While the installation on a Windows platform does not generate problems (because Ekahau supplies an “Only Windows” support) that one on other platforms (Mac Os X e Linux) needs “some” modifications to the installer. During the execution phase we have not noticed any problem.
- Ekahau Manager
 - ✓ It is supplied in the same package of the Engine, so it has the same problems during the installation. During the use, the application appears enough slow. In the calibration phase, it needs the Client installed on the same machine.
- Ekahau Client
 - ✓ After the installation of the exact drivers, the installation and the use has not created problems.

Phase 1: Wiring of the net



Since the client devices must be always connected to the engine, it's necessary a network infrastructure (wired or realized through multipoint bridge wireless).

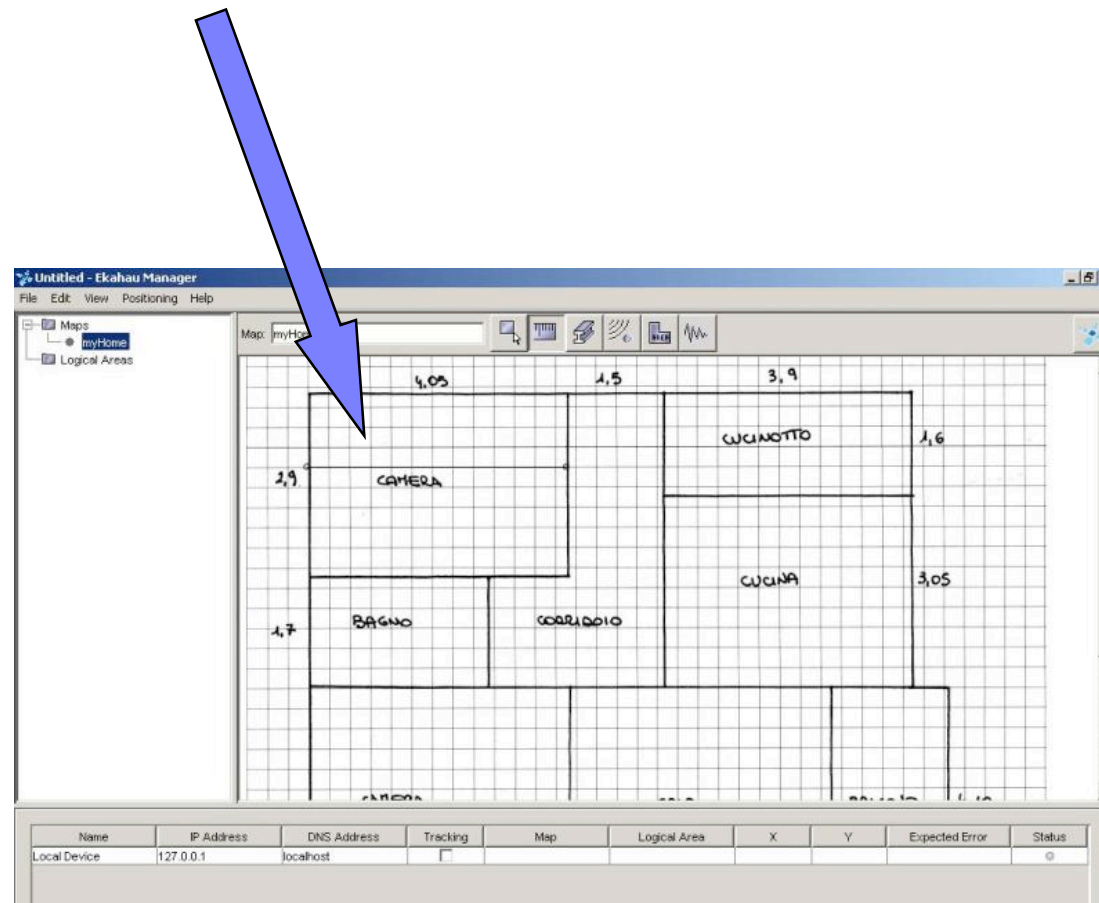
Guaranteed this condition, for the corrected position survey it can be used whichever AP whose signal is collectable from the devices.





Fase 2: Creation of the positioning model

The model creation begins after the import of the map (jpg, png, bmp) and the setting of the map scale (pixels/meter).

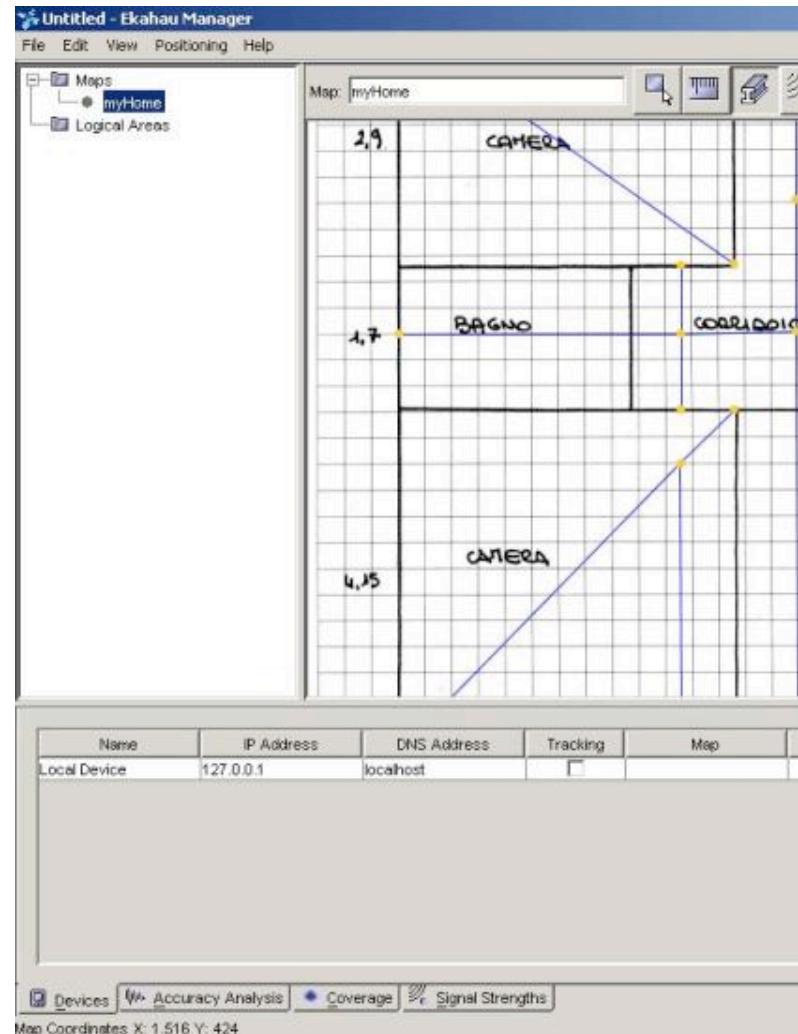




Phase 2: Drawing of the travel path

On the map you indicate the most frequently used routes, on which it will be possible to determine the points where carry out the calibration.

This phase is very important, because during the localization we have noticed that the software tries to bring the current position near the travel paths.

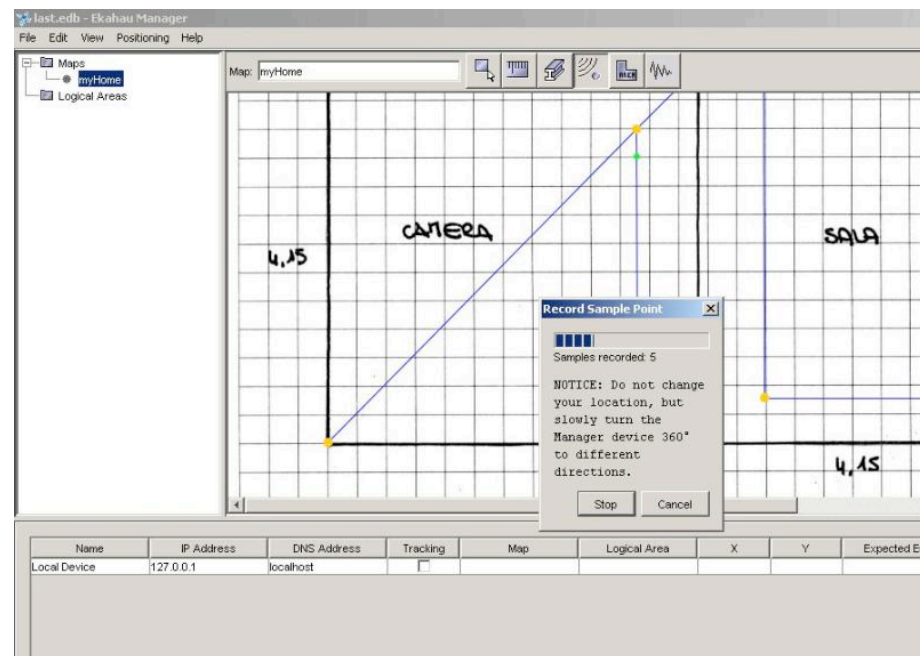




Phase 2: Calibration

For this operation it is necessary to set the device where is installed the Manager (it must be present also the Client) in some of the points of the tracking and to carry out a sampling of the signal (operation that demands the parking of the device and its spin of 360° for a time of 20 sec).

Such operation is difficult because of the dimensions of the device, being the Manager usable only on notebook, and inaccurate for the insufficient maneuverability and the possible interferences associated to it.

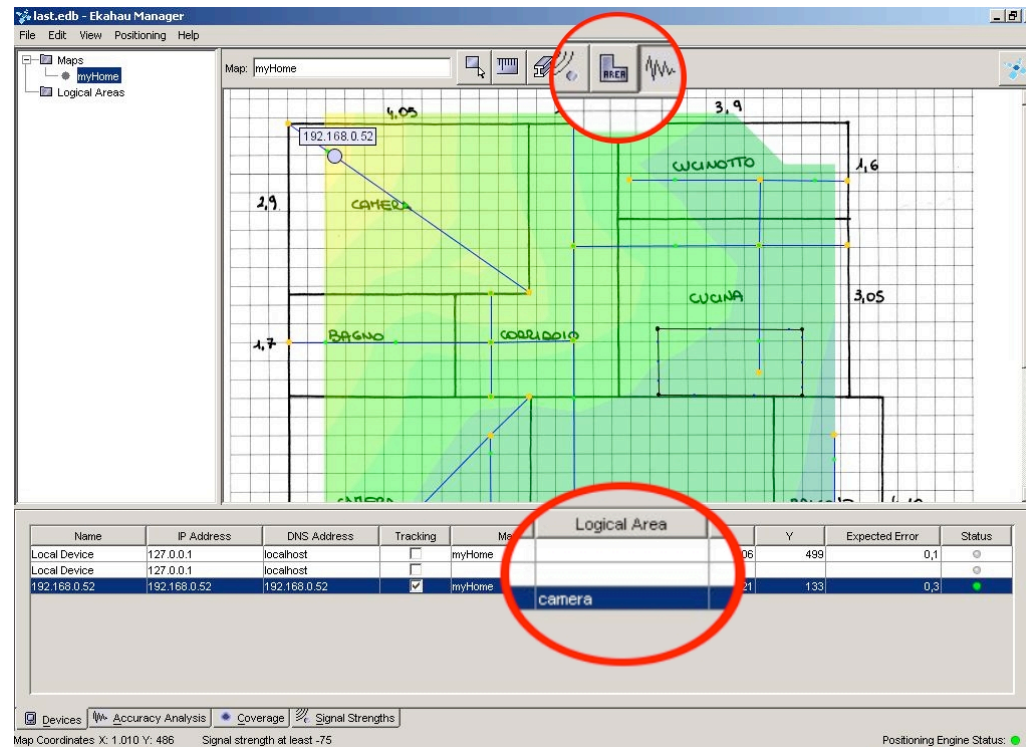




Phase 2: Logical Area's Definition

Ekahau lets you to create logical areas, defined by a polygon on the map with an associated name.

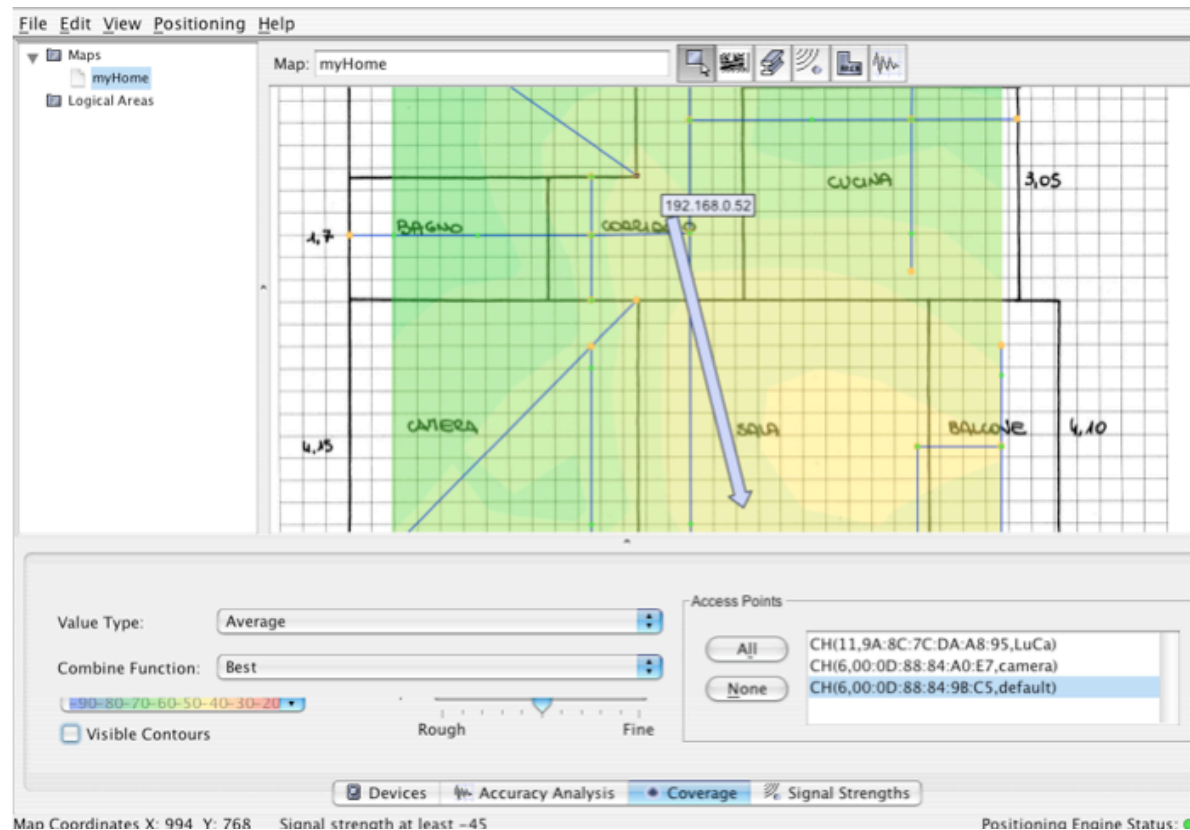
For each client device, during its localization, you will be able to locate its position as well as the respective logical area.





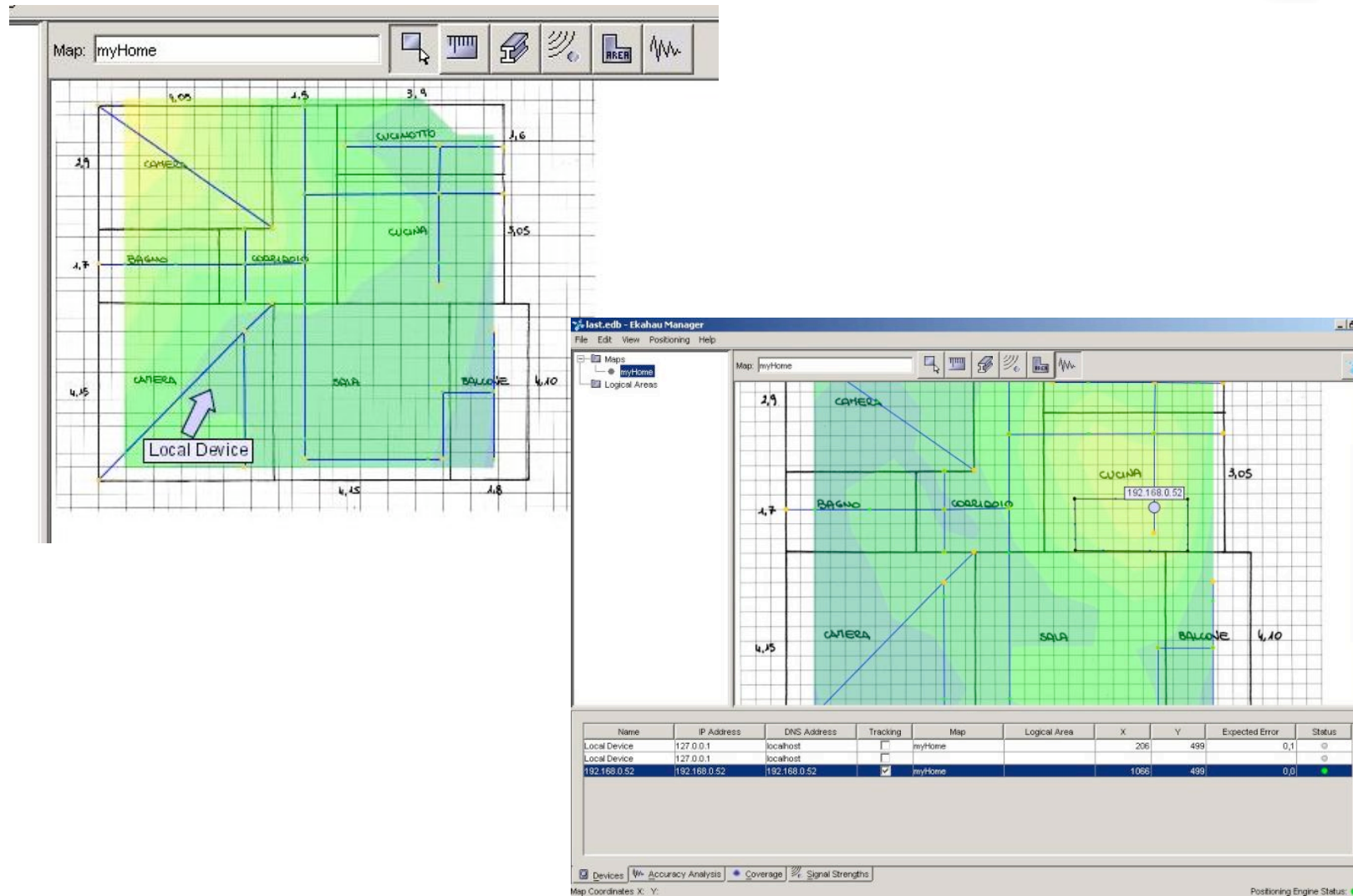
Phase 3: Localization

Finished the configuration stage, it's possible to identify devices associated to the Engine, locate their position and track their route.



Besides it's possible to display the coverage areas of available Access Point and the global signal.

Phase 3: Localization





Result's Analysis

The software, after the test's phase, turn out that is enough reliable.

From our analysis we have found out some lack and necessity:

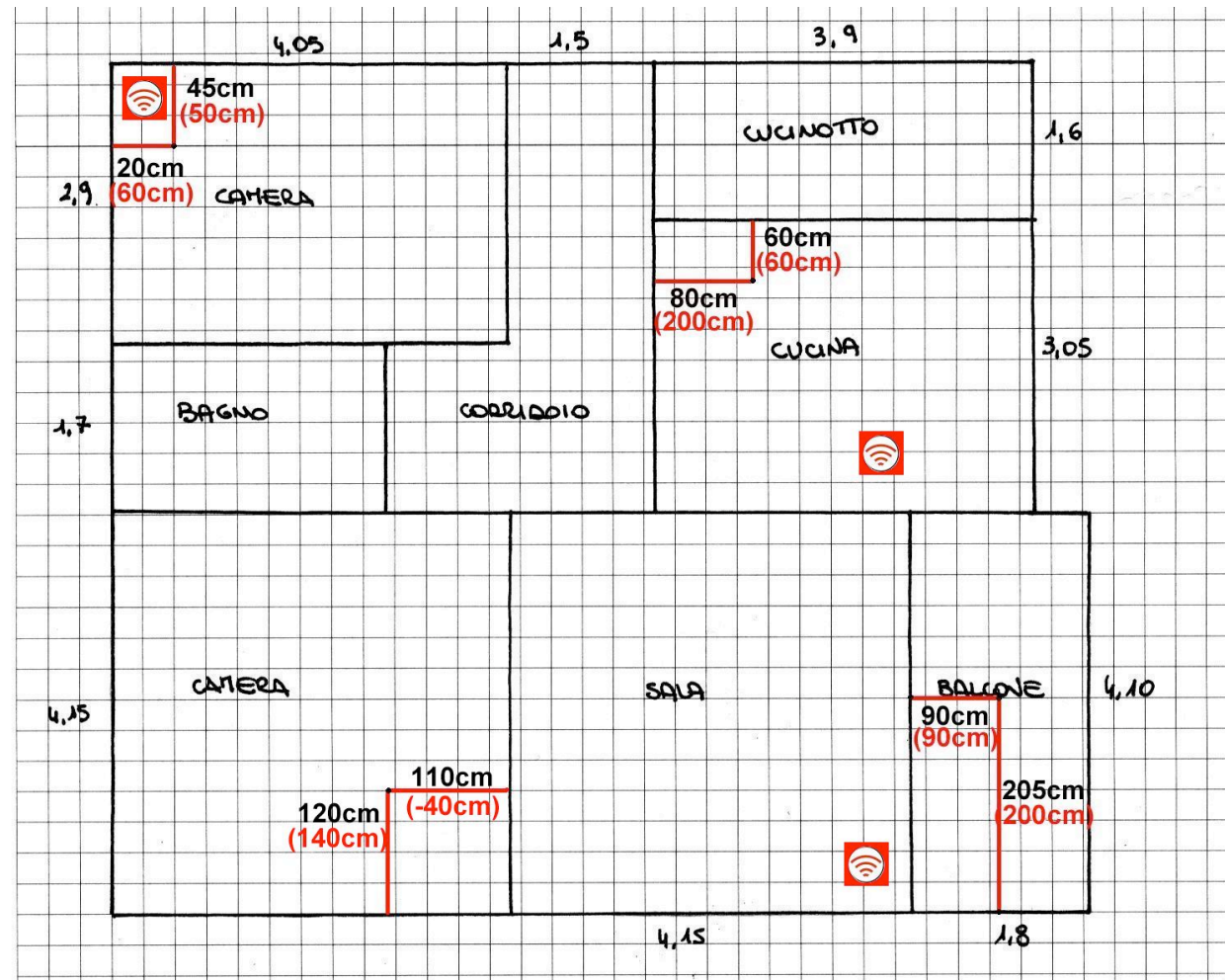
- increasing global coverage, adding more Access Point, would grant more precision;
- using an emulated AP, implemented with a laptop, has influenced the results because of poor strength of the emitted signal;
- a better choice of the possible travel paths and a greater Sample Point resolution should improve positioning accuracy;
- it's required a careful environment structure's analysis and a careful Access Point's placement;
- using the same wi-fi card employed for the calibrating phase assure a better efficiency during the next localization phase although software makes an automatic correction based on the used chipset.



Result's Analysis

Here there is the surveys' map with the real position value and the surveyed from Ekahau (in red):

The Access Point's position is point out by the following symbol:





Ekahau for Developer: SDK

Ekahau Position Engine offers for developers a Java Application Programming Interface (API), called Ekahau SDK, contains:

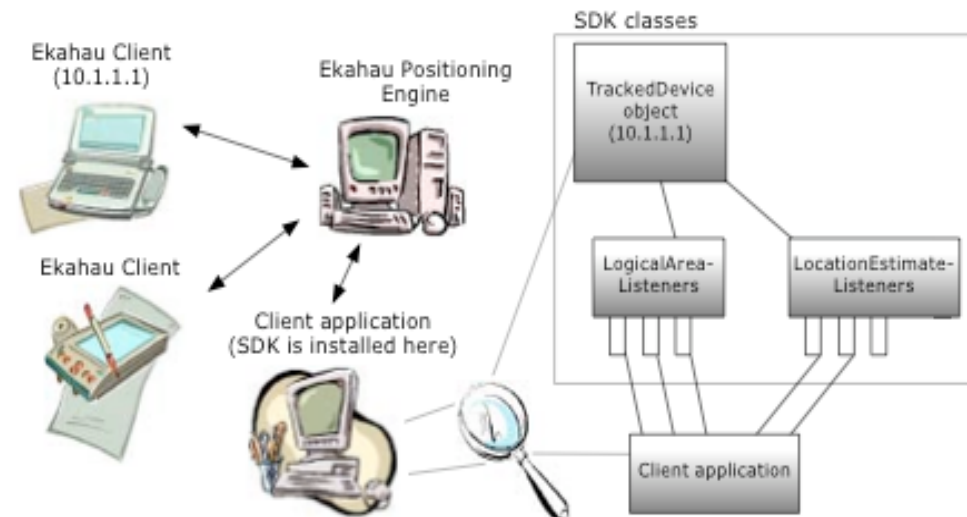
- ✓ Java Packages
- ✓ Java-doc

These tool let to create location-based application using API provided by the Position Engine.

Alternatively it's possible to use the Ekahau YAX Protocol to connect to the Engine through socket.

Examples of interactions with the Engine:

- ✓ *Connection to an Position Engine*
- ✓ *Available devices survey*
- ✓ *Listeners' creation to get localization, state and logical area data*
- ✓ *Devices position's survey*



Ekahau for Developer: SDK



We have positively tested the SDK's use with a simple application example, that locate the device's position, statically selected.

The screenshot shows an IDE with the following components:

- Package Explorer:** Shows a project named 'wifi' containing a package '(default package)' with the file 'SimpleTrackExample.java'. It also lists 'sdk.jar - C:\Programmi\Ekahau\Position' and 'JRE System Library [j2re1.4.2_03]'.
- SimpleTrackExample.java:** Contains the following code:

```
//package examples;

import com.ekahau.sdk.*;
import java.util.*;
import java.io.*;

/**
 * Tracks a device until user interrupts the action.
 * The device IP is given using a command-line parameter.
 */

public class SimpleTrackExample
{
    /**
     * @param args give the ip-address as a command-line parameter
     */
    public static void main(String[] args) throws EngineException,
        String ipAddress = args.length > 0 ? args[0] : "192.168.0.52";

    //Connect to positioning engine
    PositioningEngine.connect();

    // Find the given device:
    Device[] devices = PositioningEngine.findDevice("IPADDRESS",

    if (devices.length == 0) {
        System.err.println("Device with IP address " + ipAddress +
        PositioningEngine.disconnect();
    }
}
```
- Console:** Shows the output of the program:

```
<terminated> C:\Programmi\Java\j2re1.4.2_03\bin\javaw.exe (11/01/04 21.18)
2004    Location for the device is X:282.51798259483695 Y:267.7576377777225
2004    Location for the device is X:257.1909740815056 Y:199.2759114640545
2004    Location for the device is X:288.9324315154114 Y:242.90269123509995
2004    Location for the device is X:249.14397006405042 Y:180.06847697975152
2004    Location for the device is X:279.441192565941 Y:226.33168230442467
2004    Location for the device is X:267.94246088787526 Y:193.10871220162682
```