

5.1 Possibilities - Technology

The wireless infrastructure environment at the ETH Zürich is one of the largest wireless lan networks with eg. over 50 access points only at the HIL complex.

These access points are normally used as internet connection gates for mobile computers. ETHGame uses this infrastructure to locate single clients in a building by simply measure the signal strength of the receivable access points, of which each has it's own unique identification - the MAC address.

Having a database on the Server with all access points stored with their positions of all ETH buildings, the position of the Client can be detected by simply transferring the MAC addresses of the receivable access points to the server.

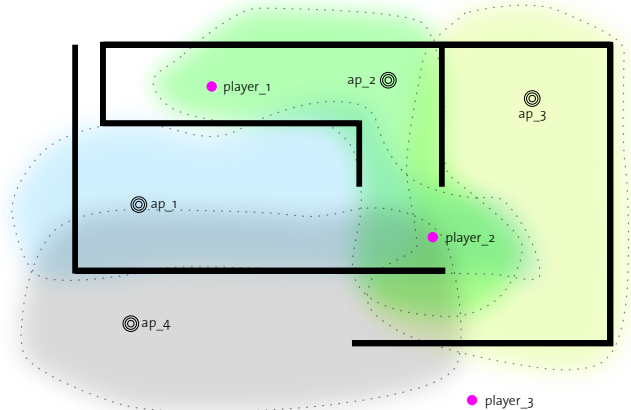


fig. 5.1.1 assumption of radio cloud (1st situation - planview)

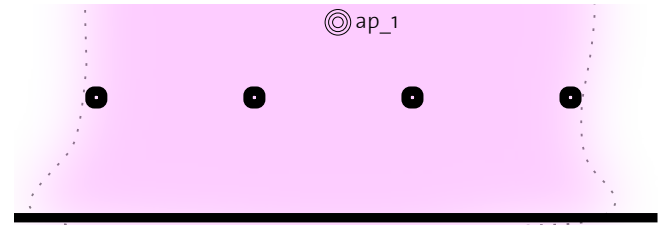


fig. 5.1.2 assumption of radio cloud (2nd situation - planview)

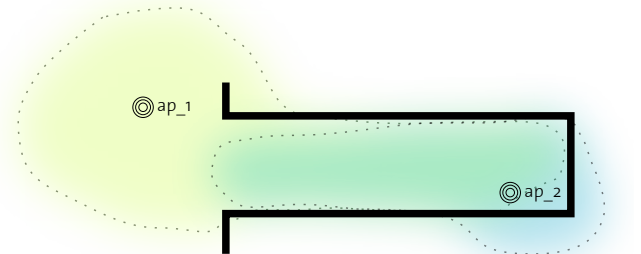


fig. 5.1.3 assumption of radio cloud (3rd situation - planview)

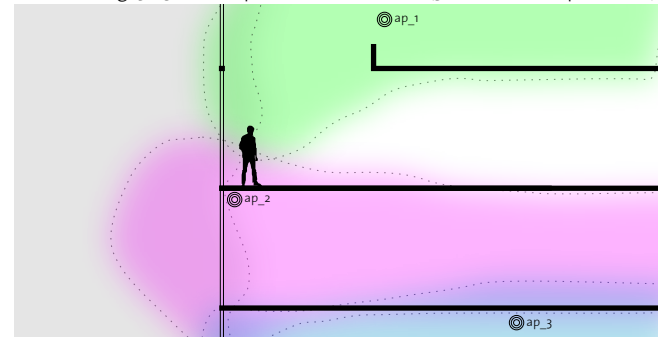


fig. 5.1.4 assumption of radio cloud (section)

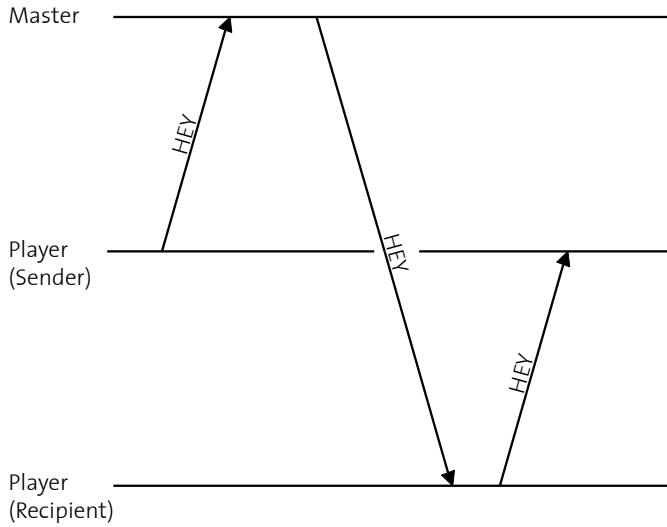


fig. 5.1.5 communication diagram (messaging & P2P)

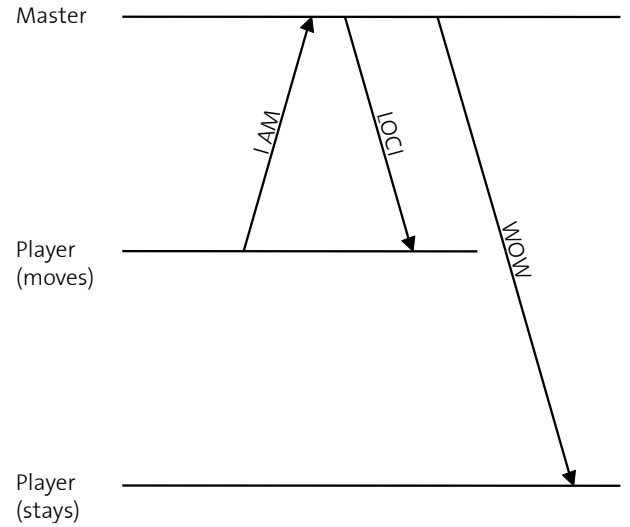


fig. 5.1.6 communication diagram (positioning & neighbourhood notification)

5.2 Limits

Signal strength measurements have shown, that in an indoor environment are a lot of factors that affect the received signal strength (eg. walls with different materials, moving people and reflecting elements). (fig. 5.2.1 + fig 5.2.3)

The charts and the list of signal strengths on the next side show how the reception changes by moving at slow speed through building parts. Also can be seen, that some access points are stronger than others (for example an outdoor access point - 00:07:50:d5:f5:c6). (fig 5.2.2)

That's the reason why a exact positioning with a triangulation of all access points isn't possible.

As a solution for locating a Client at a Loci the condition to receive the signal of two or more scified access points was defined (fig. 5.1.1)

Further an other problem occurred because every wireless lan hardware gets the signals at a different strength - or (older hardware) isn't even able to measure the signal strength.

| | | | | | | | | |
|-------------------|--------|-----|-------------------|---------|-----|-------------------|---------------|-----|
| 00:0f:23:71:ag:e6 | public | -47 | 00:0f:f8:58:od:fi | public | -21 | 00:0d:39:fo:bo:78 | public | -39 |
| 00:0f:23:71:ag:e6 | public | -35 | 00:0e:d7:48:60:8e | public | -46 | 00:07:50:d5:f5:c6 | public | -44 |
| 00:0d:65:gb:bs:48 | public | -39 | 00:07:50:d5:f5:d5 | public | -29 | 00:07:50:d5:f5:d5 | public | -35 |
| 00:0d:65:gb:bs:d3 | public | -20 | 00:0e:d7:48:60:8e | public | -35 | 00:07:50:d6:00:fd | public | -26 |
| 00:0f:23:71:ab:f3 | public | -25 | 00:0f:23:71:ag:e1 | public | -25 | 00:0f:23:71:ab:f2 | public | -25 |
| 00:0f:23:71:ag:e6 | public | -39 | 00:07:50:d5:f5:d5 | public | -35 | 00:0d:65:gb:bs:bd | public | -28 |
| 00:0d:65:gb:bs:48 | public | -32 | 00:0e:d7:48:60:8e | public | -37 | 00:0d:39:fo:bo:78 | public | -25 |
| 00:0d:65:gb:bs:d3 | public | -26 | 00:07:50:d6:03:02 | public | -25 | 00:07:50:d5:f5:c6 | public | -26 |
| 00:0f:23:71:ab:f3 | public | -13 | 00:11:24:23:e4:6b | MENZETH | -25 | 00:07:50:d5:f5:d5 | public | -35 |
| 00:0f:23:71:ag:e6 | public | -43 | 00:0d:65:gb:bs:bd | public | -21 | 00:07:50:d6:00:fd | public | -35 |
| 00:0d:65:gb:bs:48 | public | -30 | 00:0f:23:71:ag:e1 | public | -30 | 00:0d:65:gb:bs:bd | public | -30 |
| 00:0e:d7:48:60:8e | public | -20 | 00:0d:65:bb:fc:5c | public | -24 | 00:07:50:d5:f5:c6 | public | -32 |
| 00:0f:f8:58:od:c1 | public | -13 | 00:0f:23:71:ab:f9 | public | -26 | 00:07:50:d5:f5:d5 | public | -25 |
| 00:07:50:d5:f5:d5 | public | -21 | 00:07:50:d5:f5:c6 | public | -29 | 00:07:50:d6:00:fd | public | -42 |
| 00:0e:d7:48:60:8e | public | -32 | 00:07:50:d6:03:02 | public | -28 | 00:0d:65:gb:bs:bd | public | -46 |
| 00:0f:f8:58:od:c1 | public | -32 | 00:0e:d7:48:60:8e | public | -28 | 00:0d:39:fo:bo:78 | public | -25 |
| 00:07:50:d5:f5:d5 | public | -38 | 00:0d:65:gb:bs:bd | public | -29 | 00:07:50:d5:f5:c6 | public | -26 |
| 00:0e:d7:48:60:8e | public | -44 | 00:0f:23:71:ag:e1 | public | -45 | 00:0d:65:gb:bs:97 | public | -28 |
| 00:0f:f8:58:od:c1 | public | -29 | 00:0d:65:bb:fc:5c | public | -41 | 00:07:50:d6:03:c5 | public | -32 |
| 00:07:50:d5:f5:d5 | public | -26 | 00:0f:23:71:ab:f9 | public | -30 | 00:07:50:d6:00:fd | public | -32 |
| 00:0e:d7:48:60:8e | public | -42 | 00:0d:65:gb:bs:c6 | public | -28 | 00:0d:65:gb:bs:bd | public | -32 |
| 00:0e:d7:48:60:77 | public | -30 | 00:0d:65:gb:bs:88 | public | -35 | 00:07:50:d5:f5:c6 | public | -32 |
| 00:0f:f8:58:od:c1 | public | -26 | 00:07:50:d6:03:02 | public | -32 | 00:07:50:d6:03:c5 | public | -28 |
| 00:0f:f8:58:od:fi | public | -32 | 00:0d:65:gb:bs:bd | public | -26 | 00:07:50:d6:00:fd | public | -29 |
| 00:07:50:d5:f5:d5 | public | -35 | 00:0f:23:71:ag:e1 | public | -51 | 00:0d:65:gb:bs:bd | public | -29 |
| 00:0e:d7:48:60:77 | public | -28 | 00:0d:65:bb:fc:5c | public | -35 | 00:07:50:d6:03:c5 | public | -32 |
| 00:0e:d7:48:60:8e | public | -42 | 00:0d:65:gb:bs:88 | public | -43 | 00:0d:65:gb:bs:bd | public | -26 |
| 00:0f:f8:58:od:c1 | public | -29 | 00:07:50:d5:f5:c6 | public | -28 | 00:07:50:d6:03:c5 | public | -35 |
| 00:0f:f8:58:od:fi | public | -29 | 00:07:50:d6:03:02 | public | -35 | 00:0d:65:gb:bs:bd | public | -25 |
| 00:0e:84:86:0d | public | -15 | 00:0f:23:71:ab:f2 | public | -32 | 00:07:50:d6:03:c5 | public | -35 |
| 00:0f:f8:58:od:c1 | public | -24 | 00:0d:65:gb:bs:bd | public | -29 | 00:07:50:d6:03:c5 | public | -32 |
| 00:07:50:d5:f5:d5 | public | -29 | 00:0f:23:71:ag:e1 | public | -53 | 00:0d:39:fo:bo:78 | public | -28 |
| 00:0d:65:gb:bs:84 | public | -20 | 00:0d:65:bb:fc:5c | public | -28 | 00:07:50:d6:03:02 | public | -15 |
| 00:0e:d7:48:60:8e | public | -37 | 00:07:50:d5:f5:c6 | public | -29 | 00:07:50:d6:03:c5 | public | -53 |
| 00:0e:d7:48:60:77 | public | -26 | 00:0d:65:gb:bs:88 | public | -39 | 00:30:65:15:fe:09 | braunkohleNET | -35 |
| 00:0f:f8:58:od:fi | public | -26 | 00:07:50:d6:03:02 | public | -49 | 00:0d:93:7e:33:47 | eisenerzNET | -30 |
| 00:0f:f8:58:od:c1 | public | -15 | 00:0d:65:gb:bs:bd | public | -29 | 00:07:50:d6:03:02 | public | -24 |
| 00:07:50:d5:f5:d5 | public | -30 | 00:0f:23:71:ag:e1 | public | -45 | 00:07:50:d6:00:c4 | public | -25 |
| 00:0e:d7:48:60:8e | public | -43 | 00:07:50:d5:f5:c6 | public | -37 | 00:07:50:d6:03:c5 | public | -58 |
| 00:0e:d7:48:60:77 | public | -28 | 00:0d:65:gb:bs:88 | public | -43 | 00:30:65:15:fe:09 | braunkohleNET | -45 |
| 00:0f:f8:58:od:fi | public | -30 | 00:07:50:d5:f5:d5 | public | -24 | 00:0d:93:7e:33:47 | eisenerzNET | -55 |
| 00:0f:f8:58:od:c1 | public | -24 | 00:07:50:d6:03:02 | public | -45 | 00:07:50:d6:03:02 | public | -30 |
| 00:07:50:d5:f5:d5 | public | -29 | 00:0f:23:71:ab:f2 | public | -41 | 00:07:50:d6:00:c4 | public | -32 |
| 00:0e:d7:48:60:8e | public | -44 | 00:0d:65:gb:bs:bd | public | -30 | 00:07:50:d6:03:c5 | public | -75 |
| 00:0f:f8:58:od:c1 | public | -25 | 00:0f:23:71:ag:e1 | public | -28 | 00:30:65:15:fe:09 | braunkohleNET | -53 |
| 00:0f:23:71:ag:e6 | public | -35 | 00:07:50:d5:f5:c6 | public | -45 | 00:0d:93:7e:33:47 | eisenerzNET | -55 |
| 00:07:50:d5:f5:d5 | public | -43 | 00:07:50:d5:f5:d5 | public | -51 | 00:07:50:d6:00:c4 | public | -28 |
| 00:0d:65:gb:bs:84 | public | -15 | 00:07:50:d5:f5:d5 | public | -29 | 00:07:50:d6:03:c5 | public | -72 |
| 00:0e:d7:48:60:8e | public | -41 | 00:07:50:d6:03:02 | public | -40 | 00:30:65:15:fe:09 | braunkohleNET | -60 |
| 00:0e:d7:48:60:77 | public | -21 | 00:0f:23:71:ab:f2 | public | -46 | 00:0d:93:7e:33:47 | eisenerzNET | -53 |
| 00:0f:f8:58:od:fi | public | -28 | 00:0f:23:71:ag:e1 | public | -28 | 00:07:50:d6:03:02 | public | -35 |
| 00:0f:f8:58:od:c1 | public | -15 | 00:0e:d7:48:60:70 | public | -30 | 00:07:50:d6:00:c4 | public | -30 |
| 00:07:50:d5:f5:d5 | public | -30 | 00:07:50:d5:f5:c6 | public | -46 | 00:07:50:d6:03:c5 | public | -67 |
| 00:0e:d7:48:60:8e | public | -35 | 00:0d:65:gb:bs:88 | public | -55 | 00:30:65:15:fe:09 | braunkohleNET | -60 |
| 00:0f:f8:58:od:fi | public | -26 | 00:07:50:d6:03:02 | public | -44 | 00:0d:93:7e:33:47 | eisenerzNET | -49 |
| 00:07:50:d5:f5:d5 | public | -28 | 00:0f:23:71:ab:f2 | public | -47 | 00:07:50:d6:03:02 | public | -32 |
| 00:0e:d7:48:60:8e | public | -47 | 00:0f:23:71:ag:e1 | public | -28 | 00:07:50:d6:00:c4 | public | -39 |
| 00:0f:f8:58:od:fi | public | -32 | 00:07:50:d5:f5:c6 | public | -53 | 00:07:50:d6:03:c5 | public | -67 |
| 00:07:50:d5:f5:d5 | public | -37 | 00:0d:65:gb:bs:88 | public | -45 | 00:30:65:15:fe:09 | braunkohleNET | -55 |
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| 00:0f:f8:58:od:fi | public | -55 | 00:0f:23:71:ab:f2 | public | -49 | 00:07:50:d6:03:02 | public | -29 |
| 00:0f:f8:58:od:c1 | public | -25 | 00:0f:23:71:ag:e1 | public | -20 | 00:07:50:d6:00:c4 | public | -35 |
| 00:07:50:d5:f5:d5 | public | -28 | 00:0d:65:gb:bs:88 | public | -41 | 00:07:50:d6:03:c5 | public | -60 |
| 00:0e:d7:48:60:8e | public | -56 | 00:07:50:d5:f5:c6 | public | -74 | 00:30:65:15:fe:09 | braunkohleNET | -53 |
| 00:0f:f8:58:od:fi | public | -28 | 00:07:50:d6:03:02 | public | -26 | | | |
| 00:0f:f8:58:od:c1 | public | -29 | 00:07:50:d6:00:fd | public | -25 | | | |
| 00:07:50:d5:f5:d5 | public | -25 | 00:0f:23:71:ab:f2 | public | -46 | | | |
| 00:0e:d7:48:60:8e | public | -50 | 00:07:50:d5:f5:c6 | public | -46 | | | |
| 00:0f:f8:58:od:fi | public | -25 | 00:07:50:d5:f5:d5 | public | -28 | | | |
| 00:0f:f8:58:od:c1 | public | -20 | 00:07:50:d6:00:fd | public | -35 | | | |
| 00:0e:d7:48:60:8e | public | -51 | 00:0f:23:71:ab:f2 | public | -35 | | | |

access point scan (values for fig.5.2.2)

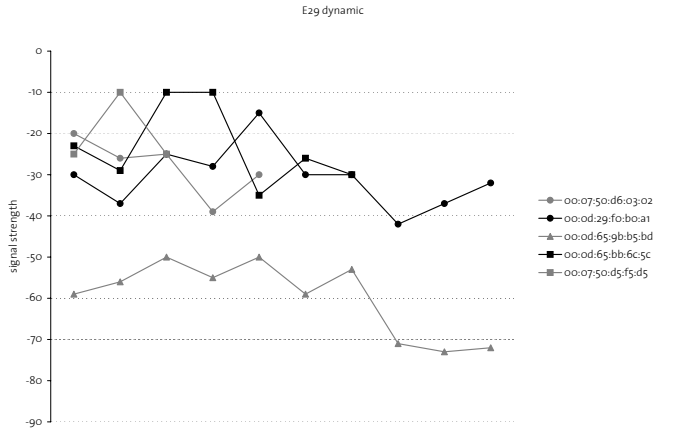


fig. 5.2.1 dynamic measurement around room hil e29

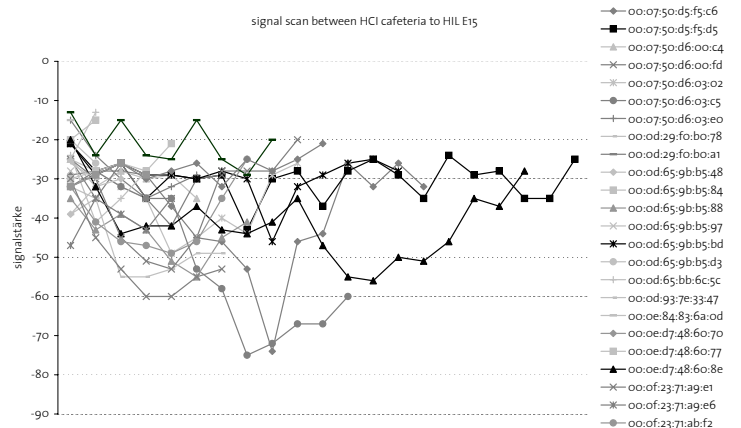


fig. 5.2.2 dynamic measurement between hci cafeteria and hil e15

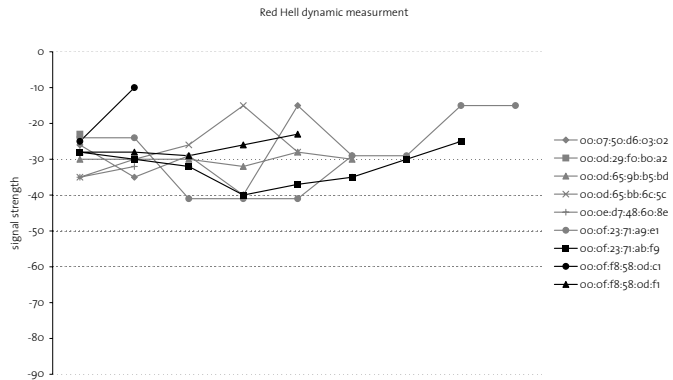


fig. 5.2.3 dynamic measurement around hil e65

5.3 Architecture

ETHGame as a highly mobile application with heavy message traffic has to be implemented with a simple and fast protocol.

Each player installs and starts a client application called PLAYER. After that the PLAYER connects to the Server thread of MASTER, sends the current available access points and receives the associated Loci with its neighbours. Additionally, the MASTER notifies the other PLAYER that there is a new neighbour.

Potential players will have many different hardware & software configurations. Therefore, the multiplatform environment Java is the best way to provide Support for the most players. Further, Java offers an easy to use network library and an access layer to locate wireless access points.

Messaging is the core function of ETHGame. And since the number of concurrent players will be high (2000 approx.), the network load will just scale with an optimal way of communication: ETHGame involves a P2P messaging tool. Illustration 5.4.1 shows how the messaging between two clients A and B works: Firstly, the PLAYER A sends a message with the recipient's name to the MASTER. The MASTER delivers the message to the corresponding PLAYER B and B can answer to A directly - peer to peer.

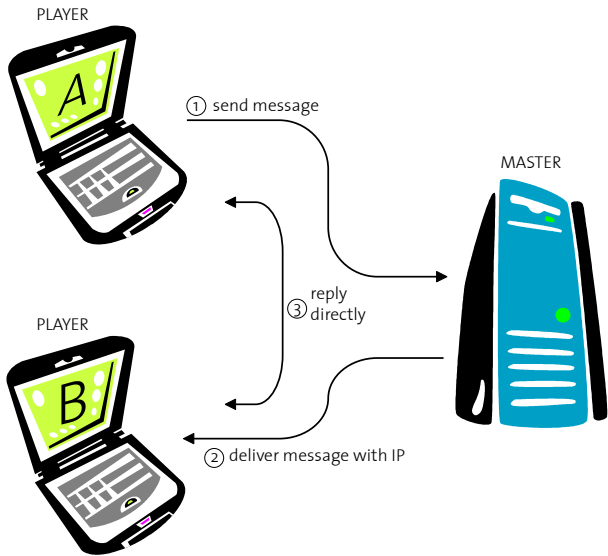


fig. 5-3.1 diagram messaging

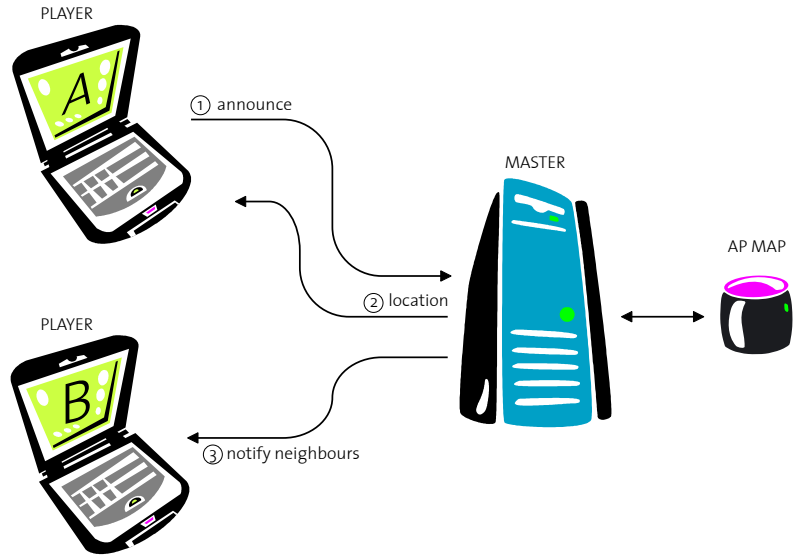


fig. 5-3.2 diagram positioning

5.4 Database

The database is designed as follows:

Players:

static information about the players is stored in this table.

Every entry is created once when registering for the game. It will not be possible to change the entries.

PlayerStates:

This table stores game-relevant information about the players. Additionally to the points/avatars and mana every player has its own IP.

AccessPoints:

An Access-Point is a physical WLAN-antenna and has its own unique MAC-Address. The geographical coordinates of the antenna position is stored in the table too.

Loci:

A Loci is defined as a set of Access-Points and is therefore not physical, but virtual. It has its own description and its own level and type.

Questions:

All the questions will be saved in this table. The Location of a Question can be either a Loci or a Player. A Question can also be a class which defines a application. I.e. a question could also be a small drawing-task. This information can be stored in the column 'data'.

Choices:

The possible answers for a question can have multiple/different points. Multiple answers are possible too.

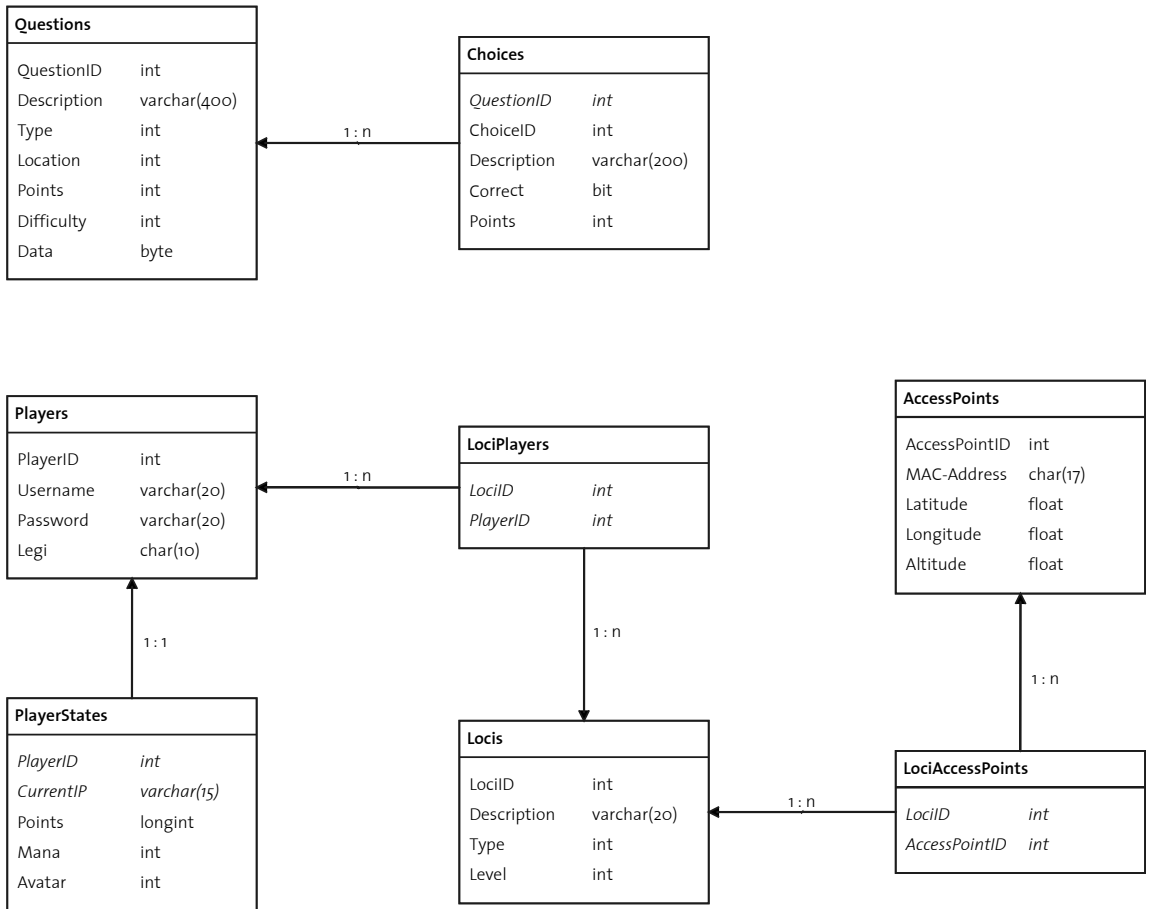


fig. 5.4.1 diagram database

5.5 Implementation

Java as an object oriented language offers the possibility of heavy code reuse. To illustrate the modeling of the two applications PLAYER and MASTER the UML notation is used. (fig. 5-5.1)

Additionally one has separated the program logic and the data. The class Database plays the role of a wrapper between the relational database (mySQL) and the GameMaster program (Java).

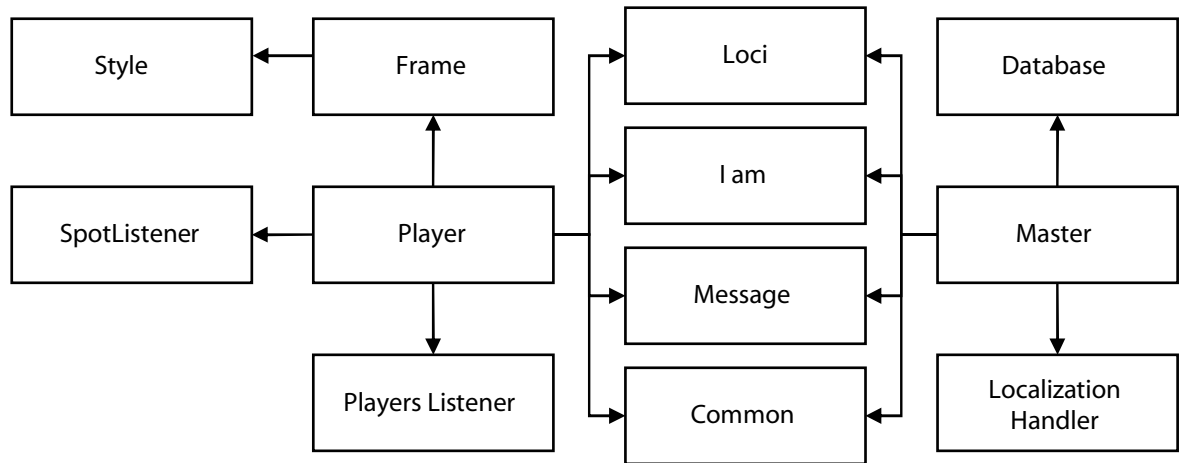


fig. 5.5.1 simplified uml diagram

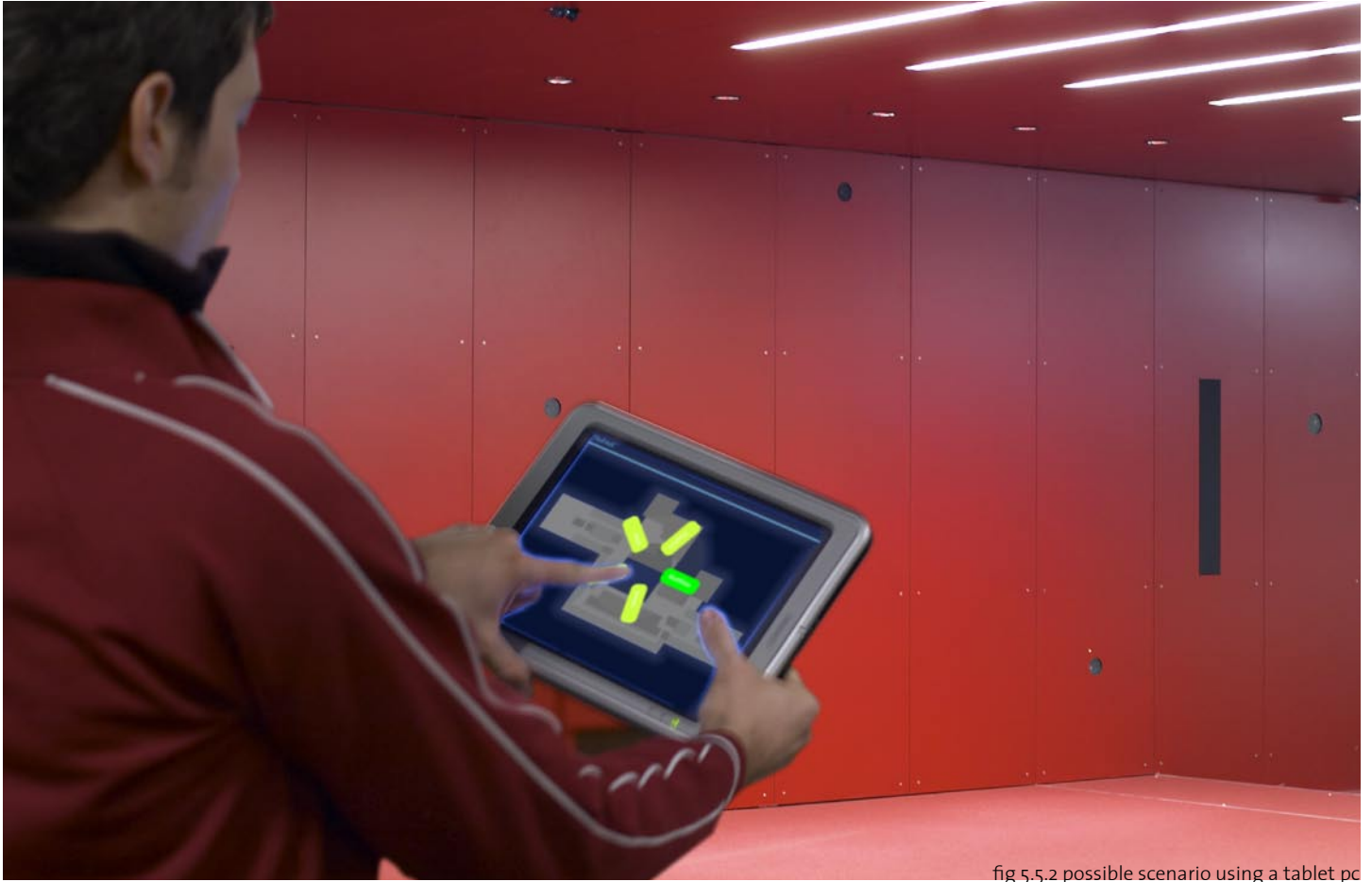


fig 5.5.2 possible scenario using a tablet pc