

# LO53 Final Test

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## 1 Indoor Positioning Systems (10 points)

### 1.1 Knowledge Questions (2 points)

Answer quickly (one or two sentences) to following questions.

- Q1. why choose Wi-Fi for indoor positioning?
- Q2. why would you choose to locate measurements on the infrastructure when implementing a positioning system?
- Q3. when collecting signal strength measurements on the infrastructure, what is the problem?
- Q4. how would you solve this problem?

### 1.2 Exercises

#### 1.2.1 Euclidean distance (3 points)

Give an algorithm to compute the euclidean distance between two signal strength vectors. The vectors are supposed to contain uncomplete lists of access points (AP) sorted by AP MAC addresses. The algorithm takes as parameters  $V_1$  and  $V_2$ , both signal measurements vectors. It returns the euclidean distance as a floating point value. You will have to complete measurements in order to match them.

*Fixed:  $V_1$  and  $V_2$  are maps:  $map<MacAddress, float>$ .*

#### 1.2.2 Positioning System Design (5 points)

You have to design an indoor positioning system. It was chosen to rely on Wi-Fi signal strength measurements to build this system. This positioning system will be provided to regular users with their own terminals (with any system).

Answer to following questions. Your answers have to be detailed.

- ▶ You choose to locate measurements on the infrastructure. Why? (1 point)
- ▶ You have to gather signal strength measurements on a device. However there is a problem due to the uncertainty to receive measurements from every access point. So, you use a signal strength gathering process. Write this process algorithm, provided the timeout parameter *meas\_delay*. Such process starts to wait during a limited time (defined by *meas\_delay*) after receiving a first SS measurement packet<sup>1</sup>. During this time, it gathers measurements. When the timeout expires, it stops gathering data and sends it to positioning server. (2 points)
- ▶ You choose to build a positioning server based on a signal strength map. Propose a database model (in UML) to store the signal strength map. (1 point)
- ▶ What could be the potential flaws in the system designed? (1 point)

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<sup>1</sup>For given mobile device and access point. Other access points will then send SS measurements for this device.

## 2 Location-Based Services (5 points)

### 2.1 Knowledge questions (1 point)

Give the advantages and drawbacks of location by mobile phone.

### 2.2 Exercise (4 points)

In the following exercise, land will be treated as a sphere.

- a) Identify and illustrate with a drawing three projection types used in mapping (1 point)
- b) Let the cities of Lille and Marseille at the respective latitudes  $\phi_L = 50, 49$  and  $\phi_M = 43, 13$ , determine the distance of one degree longitude in each city. Deduce the use of several geographic areas for the Lambert Conformal Conic projection. (1.5 points)  
Reminder: at the equator  $1' = 1$  nautical mile = 1852 meters
- c) Let  $P$  be a point located on the earth at latitude  $\phi$ . We study its projection  $P'$  on the cone tangent to the earth at  $\phi_0$  in the northern hemisphere, peak on the polar axis. (1.5 points)
  - i. Represent schematically this situation
  - ii. Determine the distance  $d$  according of  $\phi$ ,  $\phi_0$  and  $r$  the radius of the earth

## 3 Applications (5 points)

### 3.1 Knowledge Questions (2 points)

Answer the following questions:

- Q1. provide the definition of LBS applications,
- Q2. list five LBS applications,
- Q3. identify the components and participants of LBS applications and describe the interaction between these components,
- Q4. explain what context means, list five types of context awareness and list three levels of adaptation in LBS applications.

### 3.2 Exercise (3 points)

Vehicle Tracking & Tracing is an infrastructure based application that assists in remotely detecting the spatial and speed violations by vehicles. For example, geo-fencing application allows controlling the vehicles' motion and restricting their entrance into prohibited areas.

Specify the communication technologies that will provide a 2-way communication services for Vehicle T&T application. Write your suggestions by giving strong arguments?