Challenge 3: secure the route of the Olympic flame in terms of radio coverage

ANFR can measure the power received by a Smartphone from a cell on a mobile operator's network, in particular via the OpenBarres application. These measurements are expressed in dBm. The closer the value is to 0, the stronger the signal. And the stronger the signal, the more likely it is that objects connected to the network can exchange information under good conditions.

Each measurement is associated with a latitude, longitude, time stamp, operator, technology (2G, 3G, 4G and 5G) and power. For privacy and data protection reasons, these measurements cannot be published individually. On the other hand, average measurements over predefined geographical areas could be published, providing an indication of the probability of a connection in good conditions:

- between - 85 and - 41 dBm : Good
- between - 105 and - 86 dBm : Intermediate
- between - 141 and - 106 dBm : Bad

For average received power to be as representative as possible of the network, it is important to consider areas encompassing a minimum number of radio cells (a radio cell is the basic geographical unit of a mobile network in which a site hosting a base station is located). However, cell size often varies according to the population density to be covered: they will be larger in rural areas, smaller in peri-urban areas and even smaller in urban areas.

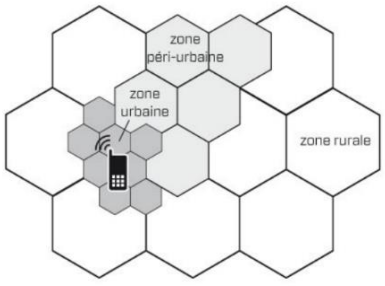
The average distance between two sites is :

- in rural areas: between 3 and 5 km
- in suburban areas: between 1.5 km and 3 km
- in urban areas: less than 1.5 km, and closer to 0.5 km in dense urban areas.

Taking a square as the elementary surface for calculating average power, this square would have a side length of between 3 and 5 km in rural areas, between 1.5 km and 3 km in suburban areas, and less than 1.5 km in urban areas.

In order for a geographical area comprising rural, peri-urban and urban zones to be fully subdivided into three elementary surface sizes, it seems necessary for each elementary surface size to be a multiple of the other.

Example with a hexagonal elementary surface:



Source : eduscol.education.fr

Each elementary surface will not necessarily contain the same number of measurements. A minimum number of measurements must be defined for each elementary surface, from which an average power will be calculated. This minimum number may vary depending on whether the surface is rural, suburban or urban. In certain elementary areas, there may be no average power received (no measurements in the area or insufficient number of measurements).

The aim of the challenge is to use a shapefile to identify the rural, peri-urban and urban areas of the 41, 45 and 89 départements, to **develop a method for squaring** these 3 départements **into elementary surfaces** and **implement it** using a software prototype, to position the unit measurements of power received in each elementary surface, then to **calculate the average power received in each elementary surface in 4G and 5G** (the minimum number of measurements considered for calculating an average will need to be specified, or even proposed as an

adjustable parameter), and finally to determine, for each operator network, the best route for the flame to cross the 3 départements via the towns of Blois, Orléans and Auxerre, with the probability of the flame crossing the towns of Blois, Orléans and Auxerre, and finally **determine, for each operator network, the best route for the flame** to cross the 3 départements via the towns of Blois, Orléans and Auxerre, with the highest probability of connection to the network and giving preference to the 5G network. The identification of the route will be based on elementary surfaces and not on the road network, and can be done visually using a cartographic representation.

The assessment criteria for the challenge will focus on :

- details of the method used to divide the 3 départements into elementary areas, and its possible re-use in other départements
- the software prototype produced, proving the relevance of the gridding method, the correct positioning of the measurements in the elementary areas on a map background, and the calculation of the average power received per elementary area
- an "ergonomic" presentation of average power received per elementary surface, enabling easy visual identification of the best route(s)

The pitch will include a detailed presentation of the corroyage method, showing how it can be reused in other departments, a presentation of the software prototype with the calculation of the average power received per elementary surface, and a presentation of the results on a cartographic background.

As with all challenges, use of the code developed for the prototype will be governed by one or more free licenses - see challenge rules.

Data available:

A shapefile of the rural areas of départements 41 45 89, a shapefile of the peri-urban areas of départements 41 45 89, a shapefile of the urban areas of départements 41 45 89, a shapefile of the contours of départements 41 45 89, a shapefile of the contours of the towns of Blois, Orléans, Auxerre and a file of georeferenced measurements.

The geo-referenced projection coordinate system used for the shapefiles is EPSG4326 - WGS 84.

A free open-source tool, QGIS[1], enables you to *quickly familiarize yourself with the contents of the shapefile* files *(Layer/Add a vector layer menu) and carry out geospatial processing*

[1] https://www.qgis.org/fr/site/forusers/download.html