# GIS supporting the Plan of BTS (Base Transceiver Stations) for mobile network in urban context

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*Abstract:* - In recent years the technological development in general and the spread on the territory of antennas for mobile phones urged a state of widespread public concern repeatedly verging the social alarm. The need for a greater territorial coverage of mobile telephone service, due to the continuous request of users and to the presence of more operators in the market, led an intensification of the installations that not only made to a progressive decrease the power radiated from individual installations, it also required that they be placed closer to homes with consequent concern of the population for their own health.
It is known that for assessing the levels of electromagnetic field in a particular place or around a given source (thus assessing the potential risk for the population nearby living) should be campaigns to measure or apply the theoretical methods (analytical or numerical).
The Municipality of Reggio Calabria in 2006 started a project having as its main purpose the development of a GIS (Geographic Information System), capable of "storing" the results of measurement campaigns and also to apply a theoretical model for developing scenarios of exposure to electromagnetic field. The aim is to assess whether the presence of fixed installations for cellular phone is compatible with the health of citizens, or if the values of exposure to electromagnetic fields produced by them are within the limits set by law. This was achieved through the implementation of a Geographical Information System able to manage, store, process all data (both alphanumeric that geographical) relating to devices GSM, GPRS, UMTS with also the possibility to update the database (Technical data characteristics antennas) and insert new installations. In addition to the management, GIS is able to calculate the electromagnetic field produced by the antennas. The SIT is therefore the final collector, performing in a single "container" the stacking phase and the monitoring of electromagnetic radiation (in operational band of GSM, GPRS, UMTS), and finally support the phases related to the remediation of areas with anomalous values of the electromagnetic field, thus supporting the planning phase of the distribution of antennas in urban context.

*Key-Words:* – Electromagnetic fields – Base Transceiver Stations – Mobile Communications – Model for calculating EF – Geographical Information Systems

## 1 Introduction

Mobile communication systems have to assure a high capability of traffic, but they have (everyone) a band of very limited frequency. This necessity induced the net planners to use the same radio ducts in small size areas, not contiguous each other (the "cells", exactly), multiplying therefore the number of the receiving stations and transmitters, said Base Transceiver Stations, designed to cover a specific area of territory. The structure of the “cellular” nets concurs therefore to increase very much the high system capacity.
The communication systems are distinguished in substantial way from radio and television spread systems because they use, for supplying this service at national level, some thousands of radio base stations, equipped with transmitters emitting, only in specific conditions, powers of some ten of Watt, while the net of emitters of a single radio TV national operator made of few hundreds of emitters that irradiate with continuity powers to radio frequency of thousands or tens of thousands of Watt.
The information and these notes make reference to systems GSM to 900 and 1800 MHz, than to world-wide level now represents the standard of dominant cellular telephony. In Italy is also used by the overwhelming majority of the customers. Modern cellular telephones operating with GSM standard are able to working also with an signal incoming to the

antenna of 10-10 mW. It happens, in fact, that the radio base stations irradiate, for simultaneously diminishing the risks of interference between various channels, signal only when necessary and sufficient at minimal level for assuring, moment for moment, the quality of the connection. Therefore the nominal power of the emitter, so as the nominal power of telephones, does not represent effectively the power with which the signal is transmitted with continuity, as instead it happens for the radio television systems, but only the peak power that the emitters are able to distributing. This is only demanded in exceptional cases and for negligible periods of time, like, as an example, when a telephone is in the extreme limit of the area of cover of a Base Transceiver Station.

Fig.1: Left, BTS with tri-cellular site; Right, BTS single antenna with dual polarization.

## 2 The electromagnetic field

For succeeding in the attempt to contain as less as possible the power of transmission signal, system GSM provides three various functionalities: the static control of the transmission power, the dynamic control of the transmission power and the transmission batch processing line. The emitters of the BTS of system GSM are planned following, on the whole, two guiding lines. In the case the stations are destined to cover territories extra-city, are installed apparatuses for signal transmitting with a sufficient power to cover cells of remarkable extension, until a few ten of kilometers. These are emitters able to distributing to the antenna the maximum power of 40 W for 1800 MHz band and of 60 W for the 900 MHz band. In the case of BTS situated in the city areas, the technical choices are considerable various. In this case, in fact, the cells, for being able to sustain a traffic the much most intense than that characterizing the areas extra-city, have a radius of little hundreds of meters. The power of signal transmission necessary for catching up customers who are near limits of the cell, even if masked from buildings or other structures, is very smaller. So the maximum power of the signal transmission is set up within lower limits. It is that one that, in technical terms, is called "configuration power", and that, in city within, it is in a generalized manner fixed on values comprised between 5 and 20 W. It must be considered that the power that arrives to the antenna is ulteriorly reduced to approximately a third party of the power of configuration for the losses in the apparatuses that allow to couple to the same antenna more emitters and the losses in the connection cables. It also exists a mechanism of "dynamics" reduction of the transmission power. This is a feature present in BTS and in individual phones: it allows continuously monitoring the level for every conversation, according to the measures, to adjust continuously, moment to moment, the minimum power level transmitters necessary to maintain an adequate quality of connection.
The dynamic control can reduce power output from the transmitter base station and mobile up to a thousandth of the power configuration set at the project level.

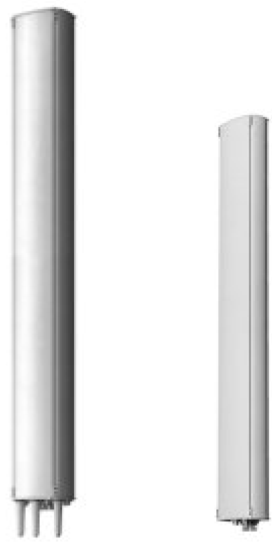

Fig.2: Some typical antennas used in the BTS.

Therefore, in the reasonable hypothesis of a uniform distribution of the user in the area covered by the cell, the medium power distributed from the BTS towards the customers during the conversations is consistently lower than the configuration power. Measures recently carried out from France Telecom in the area of Paris confirmed that the medium power of both mobile phones and BTS (understanding like average of the power that in the various moments mobile phones emit in conversation towards BTS and these emit towards the mobile phones) are equal to approximately the 25 percent of the configuration power. To this purpose, it must be observed that if it was decided, in the attempt to perhaps reduce the so-called "electromagnetic pollution", to install a few BTS remarkably separated from each other, to the limit of the residential areas, with the same distribution on the territory of the coming traffic from the mobile phones, the "pollution" would substantially increase.. This because, for maintaining the signal that reaches mobile phones and the BTS within the reception threshold, would be necessary setting the BTS at the maximum level of exit. The automatic control of the transmission power would force BTS and mobile phones to transmit almost always to the maximum level. Ultimately the generated electromagnetic field from several sources would be greater. It exists, finally, a third mechanism that contributes to limit in meaningful measure the transmission power and, therefore, to diminish the emission of electromagnetic field of the apparatuses of mobile telephony nets. In traffic absence, the BTS, in fact, constantly and continuously irradiates at the configuration power on a single carrier radio, precisely the one that works as "beacon" to the mobile phones in the cover area. This allows every mobile phone to recognize the presence of the net and receive the calls and all the necessary information to the operation of the system. This same carrier can accept until to 6-7 telephone conversations at the same time, without that this produces an increment of the issued power. All the other carrier that are in the cell (inferior or normally equal to six, with a maximum, very rare, of twelve) can accept all 8 channels at time division and transmit power on everyone of the 8 channels only when the single channel is engaged and the customer connected from the fixed net with a mobile phone produces voice activity. Finally, the mechanism of the transmission batch processing line DTX concurs to understand who between the two interlocutors of the conversation is talking, so it actives the single channel of transmission only when the customer, caught from the BTS, is in listening position. Also the UMTS system allows to define a power of feeding of the antenna corresponding to conditions of the highest emission and the functionalities of power control, and DTX contribute to diminish the transmitted power.

In the UMTS there is also a mechanism of admission control. This technology, in order to allowing to vary the power for the customers who have already an active connection, provides for the rejection of new requests when is reached the prefixed threshold percentage of the maximum power available. Moreover the UMTS system can provide a TX diversity mechanism, consisting in the possibility to transmit in downlink on two various antennas oriented in the same direction the same one less signals (of the channel pilot): it is necessary to emphasize that it does not involve an increase of the power. In fact, in a typical implementation, the same power available would be subdivided on two branches of transmission: in absence of the TX diversity, the power demanded for the single channel turns out reduced because of a greater efficiency in reception.

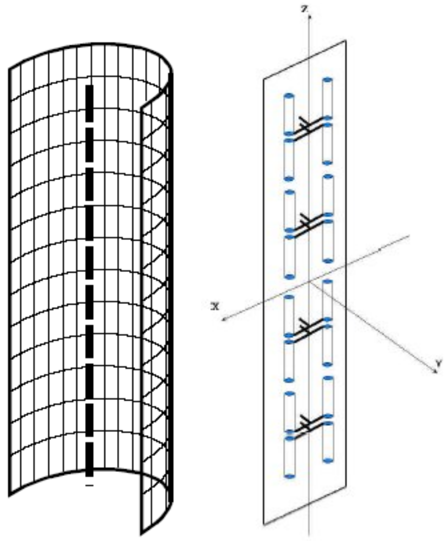


Fig.3: Drawings of antennas: reflector semi-cylindrical and rectangular.

Therefore seems necessary to make three ulterior considerations. The first is that for assuring the necessary quality of the service, the BTS are dimensioned for having at most a loss of 2 percent in the hour of maximum traffic. In practical, this means that every customer has the 98 percent of probability to find a free channel when he tries to access the network. This involves that the probability that all the channels of a cell are active in the same time also in the hour of maximum traffic is in truth very low. The second consideration regards the traffic disposed in the hours not of tip of the day, that it is, in percentage, very low, near to zero in the nocturnal hours. The third consideration leaves from the fact that the phonic activity and the signalling activity between BTS and cellular demands that it generate signal only in the 70 percent of the time, value that represents the worse case in the hypothesis of a strong background noise (as an example in railway stations or airport). After all, it can be concluded that the electromagnetic field generated from a BTS is very inferior to what could be calculated using traditional algorithms, like those used for the wireless and TV emitters. All this appears then still more important when it is considered that all the relative estimates of the electromagnetic field generated from a BTS up to now executed using the methodologies habitually in use for radio TV emitters gave outcomes of the all reassuring: the field values calculated are always turn out inferior than limits previewed from the national legislation and, to greater reason, from the European recommendations.

## 2.1 The model used

For being able to estimate the levels of electromagnetic field in a particular environment or around a given source (and therefore to estimate potential risk to which is subjected population nearby resident) is necessary realizing measure campaigns or to apply some theoretical methods (analitic or numerical) [1]. These are more fast, practical and economic than measure campaigns. The formula of "field far away" allows to estimate the field far away using a valid relation in conditions of far field and a situation of free space, that is avoiding to consider the reflections from the land, the buildings, the vegetation and eventually present orographic conditions. Such expression concurs to estimate the electric field (E, expressed in V/m), and the hypothesis of flat wave the magnetic field (H, expressed in A/m) and the density of power (S, expressed in W/m2) which are quantity directly inferred from the electric field, to which they are linked from the relation of flat wave,

$$S = \frac{E^2}{\eta} = \frac{E^2}{377} = 377 * H^2 \quad (1)$$

Some of the parameters that enter in game in the formula of far away field will be widely described later on.

### 2.1.1 Calculation of electromagnetic field levels

For the typical frequencies of the BTS and for the distances in game the condition of "field far away" can be satisfactory. In fact, in the case of the systems of mobile telephony, the wavelength is 0,333 meters in the case of the band to 900 MHz and 0,166 meters in the case of the band to 1800 MHz. We can consider that at a distance higher than few meters from the emission point (as an example a standard antenna with height of L=1,3 m) the electromagnetic wave is considerable as a wave flat and therefore the intensity of electric field and magnetic field is constant and proportioned. In particular for GSM system to 900 MHz is verified the condition of field far away at

$$\frac{2d^2}{\lambda} = 10 \text{ m} \quad (2)$$

Therefore, to great distance from the source, the expression that allows to estimate the power density is as follows and we can obtain it if we know the antenna gain value and the feeding power through the relation:

$$S(\theta, \varphi) = \frac{P \cdot G(\theta, \varphi)}{4 \cdot \pi \cdot d^2} \quad (3)$$

Where d , θ and φ are the point of evaluation of power density in a spherical system of coordinates reported to electric centre of the source.

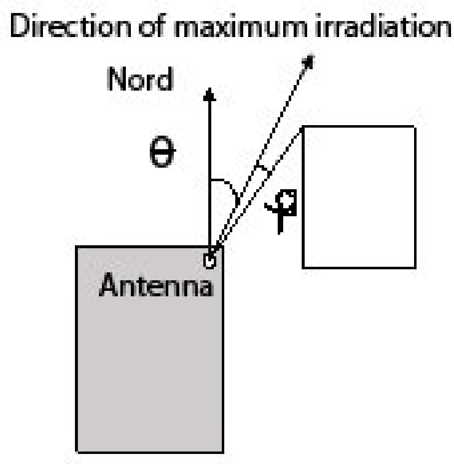


Fig.4: Assessment in plant of the angle formed between the direction of maximum radiation and the point of calculation.

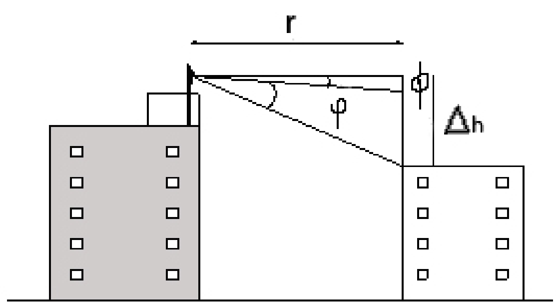


Fig.5: Assessment section on the angle formed between the direction of maximum radiation and the point of calculation.

Such expression can be obtained through appropriate considerations from the power transmitted by the antenna, its gain, the received power considering a receiving antenna and its effective area, defined power as the relationship between the power received available for loading and the density of power in absence of the antenna. By applying the relationship of impedance in terms of electric field we can get:

$$E = \frac{\sqrt{30 * P * G(\theta, \varphi)}}{d} \quad (4)$$

Where:
E = electric field in V/m;
P = power irradiated from the antenna in W;
θ = angle in the horizontal plan between the direction observation antenna-point and the direction of maximum irradiation of the antenna;
φ = angle in the vertical plan between the direction observation antenna-point and the direction of maximum irradiation of the antenna;
$G(\theta, \varphi) = 10^{dBi/10}$ gain of the antenna in the considered direction;
d = distance (m) between electric centre of the antenna and the point where we want calculate E. For the appraisal is necessary therefore the complete acquaintance of the radio-electric data of the system.

#### 2.1.2 Calculation of the levels of field in presence more sources

In the greater part of the real situations we find more transmitters antennas that, working on various systems, cover the same fields or they have diagrams of irradiation meaningfully overlapped with the main lobes.

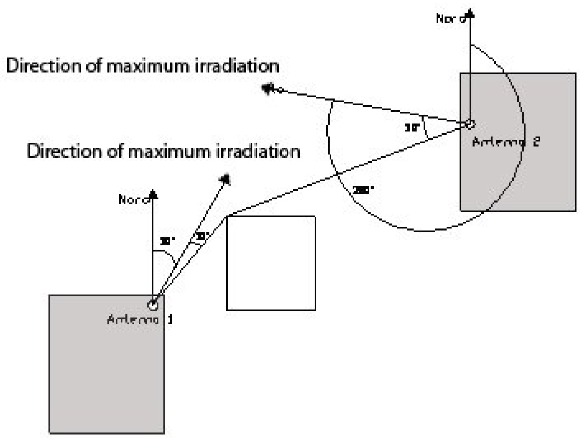


Fig.6: Calculation of the field in presence of several sources - Plan.

Naturally it is necessary to estimate the electric fields generated taking into account at the same time the emissions of every single antenna [2]. Considering that the sources of signal turn out not correlated, the contributions of field are quadratic added, so the electric field in a point will be:

$$E = \sqrt{\sum_{i=1}^{N} E_i^2} \quad (5)$$

Where N is total number of sources that generate the total field.

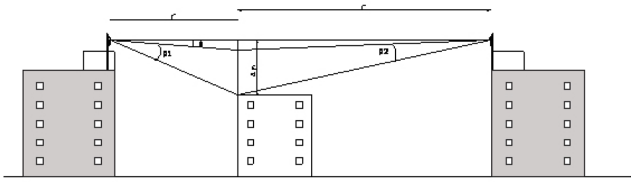

Fig.7: Calculation of the field in presence of several sources - Section.

### 2.2 Measuring stations

Generally, the chosen criteria of the points for survey, the frequency of sampling and the characteristics of the measure systems strongly depend on the preventive acquaintance of the territory to monitoring, particularly as regards sources (number, spatial distribution , characteristic emissive) and the levels of electromagnetic field emitted (definition of sites "hot" and of priorities of monitoring). Where possible, or when we know the characteristics of sources, it is opportune to make of the forecasts of principle about the expected values of electromagnetic field. From these forecasts we get the first indications for the choice of the instrument and the sensors to choose (Fig.8). On the planimetry of the places that must be controlled (are they not built up areas, city roads and areas, buildings and parts of they) we determine the points of reference for which detailed forecasts of field will be come true.

Fig.8: Unit of measure installed in the area of study.

The measure points are characterized in correspondence of the zones of maximum radiation of the systems and in proximity of the pertinence zones of the nearest rooms, particularly in the buildings with equal height than the installation site.

## 3 Implementation of GIS software

The geographic information system was realized in various steps and has demanded much time is for to get the data employed and for the implementation of the instrument survey necessary for to know the coordinates of some sites and the electric field values. In the first place, the first phase has been dedicated to the collection of the necessary data in order to know the exact positioning of the systems installed on the municipal territory of Reggio Calabria. For being able to then realize the calculation in the area of study (sited in Piazza della Libertà) had to be known radio electric characteristics of the installed systems. The relative data for registering the systems have been supplied from three of the four main providers of mobile telephony, while has been possible to have all the characteristics of the systems sited in buildings adjacent to the Piazza della Libertà. In table 1 is indicated the total number of installations in the territory of Reggio Calabria for every provider..

| Provider | BTS number |
|---|---|
| 1 | 51 |
| 2 | 30 |
| 3 | 42 |

Table 1: Number of BTS in Reggio Calabria for every provider

### 3.1 Catalog mobile telephony systems

Data deemed necessary to define a site are:
- Provider;
- Municipality - Address - Province;
- Elevation;
- Coordinates

So it is possible to georeference sources and to visualize therefore the impact on the land and the surrounding buildings. For registering of the sites it has been necessary to use the CartLab software, release 1.0, because the coordinates of the sites were provided, by some providers, with geodetic system of reference the European Datum 1950, while the orthophoto of the Reggio Calabria city are in the national system (ROME 40) and are in coordinates GAUSS-BOAGA. So with the CartLab software we had, at first, proceeded to operate a passage between systems subsequently, carrying geographic coordinates ED 50 of the sites in geographic coordinates ROME 40, these geographic coordinates were converted in coordinates plane GAUSS-BOAGA. After that, we used ArcGIS software of ESRI for the realization of the installation cadastre. Initially, through the tool ArcCatalog, we created the shape-file named 'siti' and 'celle' of point type. Then in the other tool ArcMap are load these shape-file and the file with extension ECWw related to orthophoto of Reggio Calabria city, obtaining for everyone various layer correspondents. Later we populated the layer 'siti', by knowing the plane coordinates, and we obtained an appropriate point on the installation site, and for this layer 'siti' we created and populated the attributes id, address, coordinated X, coordinated Y, elevation. For privacy on the name of the providers we indicated for every site all the points with identical colour (green circle), not allowing therefore any distinction of the telephone company owner of the site. Finally we proceeded with the digitalization of the buildings through appropriate shape-file 'Buildings' of type polygon and with the creation of the layer buildings containing all the buildings of the city of Reggio Calabria, having as attributes the altitude of the buildings at the foot and the elevation at eaves, and also the type of building (generic, industrial use, school, church, hospital). The availability of the communal cartography in scale 1:2000 allows, once placed the systems on the installation site, to identify in proximity of the source buildings particularly exposed with height similar to the installation elevation of the BTS or buildings along directions of maximum radiation or sensitive sites like schools, hospitals. Closed the insertion of the systems, in Fig. 9 is shown the impact of the BTS on the communal territory of Reggio Calabria.

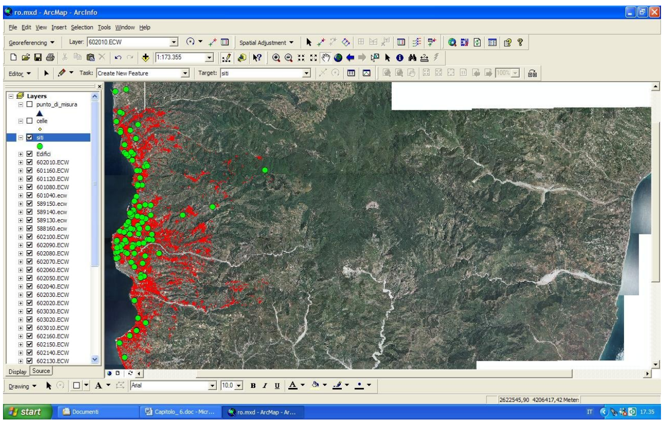

Fig.9: Impact of the BTS on the municipal territory of Reggio Calabria.

### 3.2 Features and functionality of the realized software

For evaluating the levels of field electrical through the field expression far away we have created a software of calculation still in experimentation phase. For the realization of this software it has been necessary to create a database that collects the information to manage, allowing at the same time of having a centralized cadastre of sites, beyond to the archives on used GIS..

### 3.2.1 Database structure

This database has been realized through applicative SQL Server Enterprise Manager that has allowed to create some tables then related creating a classic model entity-relations. The main entity of the db is the table ANTENNA, with its id as primary key. In the table antenna there are also the attributes related to the gain and an attribute in order to allow the insertion of the images of the system available and the id of other tables MODEL ANTENNA, POLARIZATION, FREQUENCY, TILT ELECTRICAL WORKER in which are attributes, beside id and code, also numerical value and the sign for the polarization. These tables are connected with relations many to one to the table ANTENNAS (that is for every antenna are a single value of frequency, one only of tilt, one only of polarization). In the table MODEL ANTENNA there are the relative attributes as code model and the id of the constructor, further than the description of the antenna type. Therefore, connected to it with relation one to one, there is the table CONSTRUCTOR with just id and code, corporate name, address, etc.).

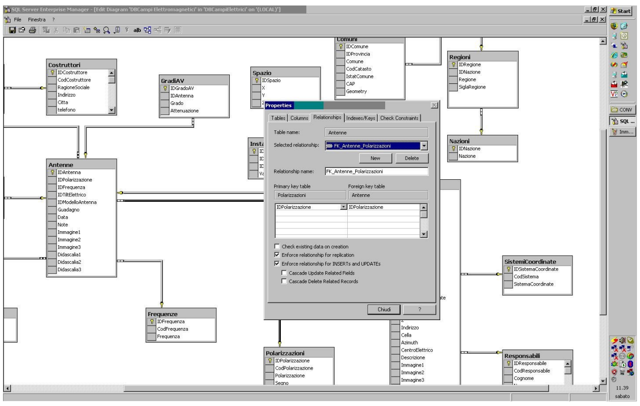

Fig.10: Building the diagram in SQL Server Enterprise Manager.

Moreover to the table ANTENNAS the tables are related DEGREE AO and DEGREE AV (relation one to one), than beyond to id the degree and to id the antenna contain the attributes degree and attenuation in order to insert the values associated. The table INSTALLATION concurs to estimate for every antenna all the characteristics on localization (Address, section, sheet, attached, particle, coordinated X,Y, Z etc.) and radio-electric (power, tilt mechanic, number of cell, height centre electrical, azimuth, etc.). To it connected with relation one to one we have the CO-ORDINATE tables SYSTEMS (Id, Code, System coord.) and RESPONSIBLES (Id, Code, Name, Address, etc.) in order to characterize the type of used coordinates and the provider of the system. Moreover, connected to the table INSTALLATION there is that COMMON (Common Id, Id Province, Common, CAP, etc), with in its turn connected the tables PROVINCES, REGIONS, NATIONS, all between they tied from relation one to one. Finally in order to concur the calculation of the values field generated from various installations we created table INSTALLAZIONISPAZIO (Id, Id Spazio, Id Installations, Value) with the attribute Value that takes the value of field estimated from the software for the single installation.

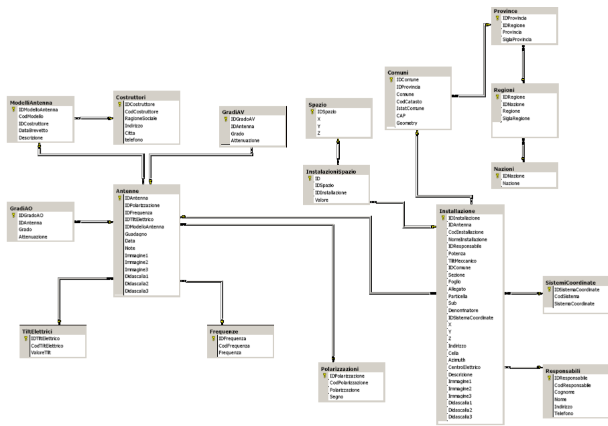

Fig.11: DB Diagram.

To table INSTALLAZIONISPAZIO the relative table is tied SPAZIO of the calculation grid of the electric field who then allows to consider the values generated in the point with appropriate coordinates and to carry out the quadratic sum. In Fig. 12 we can see the final database with the insertion of the existing relations between the tables, created selecting the commando new database diagram.

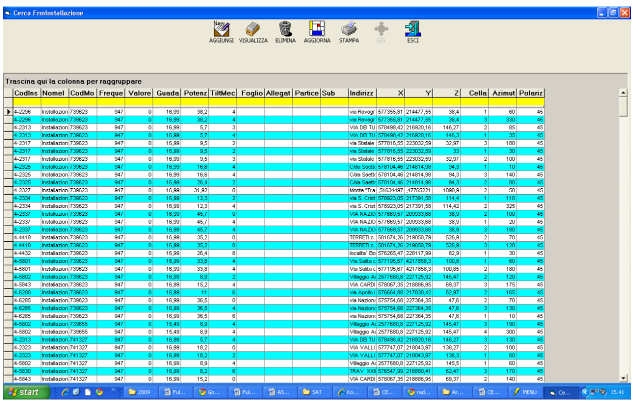

Fig.12: Software interface. BTS Data

### 3.2.2 Structure of the software

Contextually has been planned inside DIMET Department a software that allows to use this database like source from which reaching the necessary data in order to operate a control on the levels of pollution produced from the telecommunication systems. For the realization of a software that answers to the requirements before indicated is devised a tool personalized that allows to carry out simulations and at the same time to work on the territory.

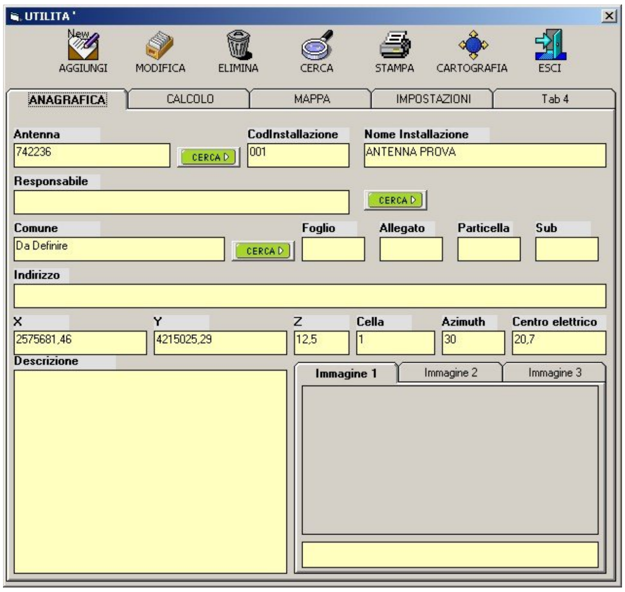


Fig.13: Mask with key accounts and geographic information.

At this aim it has been developed the software in editor Visual Basic, that it allows to carry out modeling simulation in conditions of far away and free field without considering the contributions of reflections and diffractions by orography of the land and the systems inhabited , mainly precautionary situation. The points of force of the plan are essentially two: the database on which it supports the software and the cartography in digital format, containing the information on the territory. The procedure to follow for the calculations is of the type:

- Insertion in the archives of the identifying and geographic data of the site and all the technical data of the cells;
- Identifying of the site in the area inside the georeferenced archives;
- Preparation of a plan of theoretical appraisal of the electric field irradiated through selection of the studied sites.

To the scope are graphically selected the sites hosting systems (on the same site can coexist more systems). To every site are connected the information of the georeferenced telephony systems with their technical data necessary for the appraisals. From the code of the antenna type and from the frequency, the polarization and tilt electrical for the antenna in the installation site, the software search inside of database the selected antenna type and finds the values of horizontal attenuation and vertical of the chosen antenna associated to the calculation point. Therefore it is possible to visualize the attenuation diagrams by means of image.

### 3.2.3 Output of the program

Actually calculated values of the electromagnetic fields can be visualized in shape of values of electromagnetic field with punctual esteem of the effective value of the field electrical in correspondence of identified buildings or particularly interesting places. The distances, the height and the angle formed on the plan between direction of maximum radiation and direction of the calculation point, have been manually obtained from the communal cartography while the angle on the vertical plan between direction of maximum radiation and direction of the calculation point and the punctual value of the field has been calculated directly from the software.

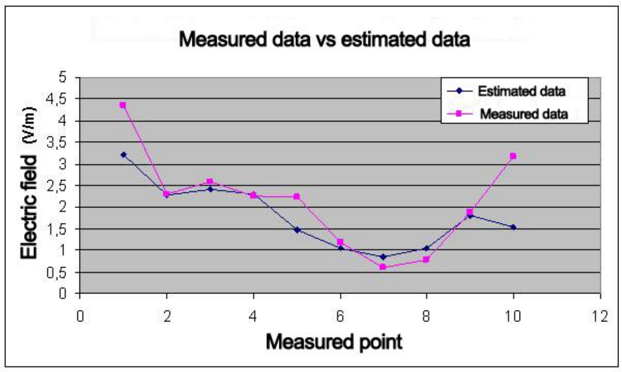


Fig.14: Measured data vs. estimated data.

The measured values and predicted values have good correlation, but the differences between them have a considerable variability [7], because between the different points were different conditions in which the measures were carried out, with regard to:
- Presence of barriers at some points of measurement;
- Presence of reflective surfaces between the different points;
- Fluctuations in the power of the plant.

In literature there are several treatises concerning the modeling of the effects of field. In particular, the applications refer to the calculation of the electromagnetic field through the use of programs. These SW, performing very well in 3D, on the contrary are limited by the computational burden and a limited scope of analysis; in recent years we have witnessed a data integration output within GIS applications [8] [6] [5].

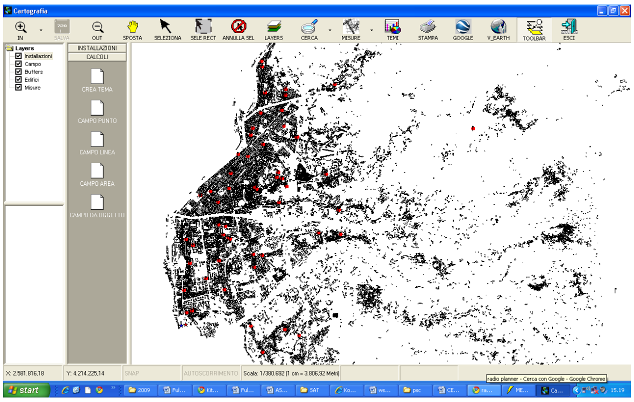

Fig.15: Software interface. Systems installed on the municipal territory of Reggio Calabria.

It is in phase of experimentation and definition the realization of horizontal maps of the effective value of electric field overlapped to the cartography of the zone selected in which the area of calculation is subdivided in cells (grid) and the software calculates the value of field at the centre of the cells.

#### 3.2.4 Future developments

The improvement of the software to short espects the optimization of the software for realizating horizontal maps of the overlapped levels of field to the cartography of the selected zone;

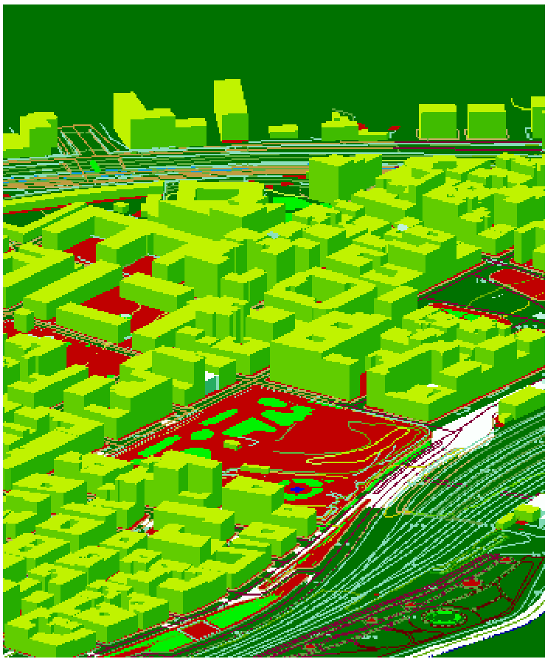

Fig.16: 3D view of the municipal territory.

In future the developments of the software will be able to produce:

- vertical maps of the effective value of electric field in the direction of maximum radiation;
- geographic information on the sensitive areas (destination of built up use city);
- geographic database on which placing the various thematic maps of the level of electromagnetic pollution;
- possibility three-dimensionally to visualize the solid of total irradiation and overlay to the surrounding city environment, using the new cartography of the communal territory.

### 3.3 Application

In the case study were placed four systems, one for every single provider. In the application the characteristics of this systems are visible, that is the flat coordinates, the elevation of the electrical center as regarding the ground as on the sea level, the identifying number of the field, the direction of these fields regarding the north, the frequency, the gain and the usable maximum power in escape to the antenna connector. In the orthophoto in the GIS can be identified CEM and the relative sector cells of irradiation organization of the analysis zone, with the sources and the positioning of the points of instrumental measure of the electric field. It is proceeded therefore to the calculation of the contributions of field for every source on the points considered. Moreover, although as said the software is in phase of definition, it is shown a demonstrative application of the realization of the horizontal maps of field in the area of study, considering two of the four present systems.

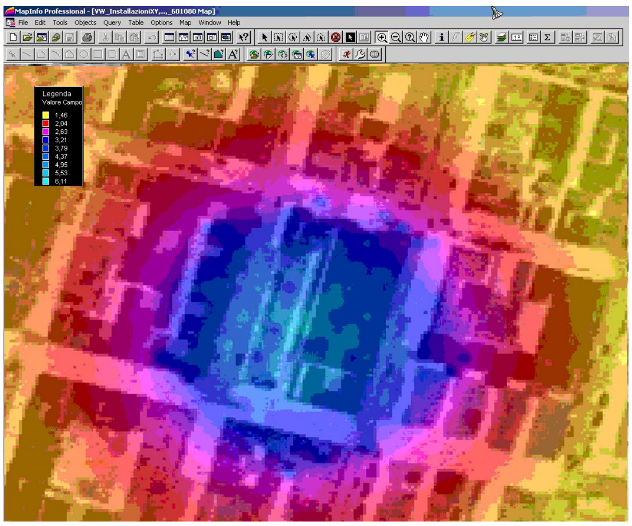

Fig.17: Output effects of EM field on cartography.

In Fig. 17 is proposed for a demonstrative aim a map of field for an area of 200 meters from sources, than however it does not represent the real distribution of the field values, but it renders only the idea of that they will be turns out once defined the software.
The conducted model simulations on the interest points was compared with the results of the instrumental measures with the comparison between the esteem and the "traditional" experience in measurement with probes of wide band.

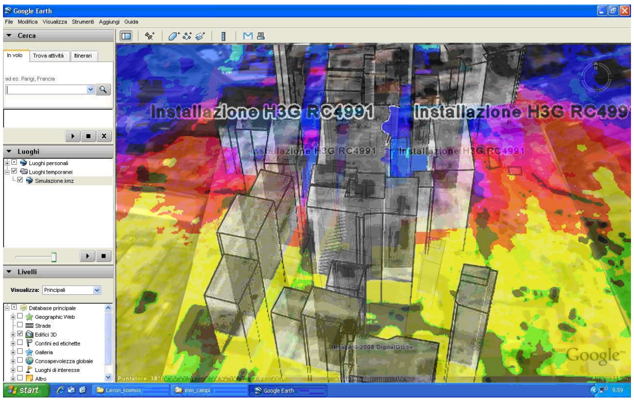


Fig.18: Horizontal Map of electric field. Google earth simulation.

## 4 Conclusion

The chosen area is characterized by a peculiar urban place and from an important presence of BTS installed on the buildings. In every point of measure it has been found it is cartographically, with the aid of the ortofoto, is through detector GPS, the exact position of measure. Through the layer of the buildings, it has been moreover found the height from the ground of the measure sensor. From an analysis of the data available the model appraisal overstates in some case is observed that the value effectively measured with the probe to wide band, while in others it is almost coinciding with that measured and in two cases understates the value found with the appropriate instrumentation. Generally the considered model stretches to overstates the values of field systematically then measured. In this case, the values tend to coincide in the comparison points since probably several measures have been realized on the terrace of the buildings, where not there is the presence of obstacles and the model of free space is sufficiently valid. Moreover on analyzed site the providers have active all the carriers for being this a central zone of the city. Naturally for the points where measured value is higher than that estimated, it is necessary to specify that the instrumental measurements can be influenced by the presence of the electric field generated from sources radio-tv, from other emitters for public service, like the antennas of the civil protection, the Fire Departments, of the cross white, military, various police officers, police, many of which are featured on this site.

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