TERIA: The GNSS Network for France

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Key words:

SUMMARY

The French Union of licensed (private) Surveyors, Ordre des Géomètres Experts (www.geometre-expert.fr), is launching its own permanent network of GPS stations, with the intention of covering all the French territory by the end of 2005. It will be one of the largest GPS networks in the world. Till now, more than 600 surveyors (i.e. about one third of all French surveyors) have associated themselves to the project. A consortium of companies, bringing together Thales Navigation, Martec-Tekelec and Geo++, have been chosen for the implementation of the network, which will be compatible with the French national mapping agency (IGN) own network. It should provide any user, in particular the French surveyors, with a centimetre accuracy. It will also be accessible to any other interested user.

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1. ORIGINS OF THE TERIA PROJECT

The Order of Licensed Surveyors (OGE) is a member of the French National Council for Geographic Information (CNIG), which is an inter-ministerial and inter-professional body, and which has established a Static and Dynamic Positioning Commission. Among other things, CNIG conducts a technology watch in the field of GPS, and offers its members scientific news about the development of related operative modes. It also seems that, currently, GNSS networks are becoming increasingly common in many countries, and that France needs to work toward the coverage of its entire national territory.
Furthermore, the Law on Construction and Sustainable Development of 1995, which was supplemented by the Decree of December 26, 2000 also made it mandatory to associate the work of the French surveyors with a national reference, known as the RGF 93.
The OGE therefore believed that such a network would offer solutions to its members, which would enable them to comply with the Law and modernize their approach to their public service mission. May we remind the reader, at this point, that the French "Geometre Expert" is entrusted with a public mission: to identify the limits of real property.
After making sure that the project was received favourably by our fellow surveyors, a consultation was initiated with manufacturers for the creation of a "GNSS" network, based by definition on existing satellite systems (GPS, Glonass) as well as on future systems (Galileo).

2. A FEW WORDS ABOUT GNSS

GNSS is the acronym for Global Navigation Satellite System. It refers to all kinds of satellite coverage; everybody knows that GPS is American, Glonass Russian and the future Galileo European. When all three systems are operational together (around the year 2010), there will be nearly 70 satellites providing their messages to users. It is obvious that the ease of use will be entirely different, since in order to measure positions in real-time without interruption, it is necessary to get constant reception from at least five satellites.

The advantage of the reference network is of course economic, since the user only has to purchase a single receiver; but there is also an operational advantage, as the network provides data according to a single reference set for everyone. Positioning production will therefore be homogenous throughout the country and will not suffer, for example, from the inaccuracies of local position determinations.

3. A FEW WORDS ABOUT OGE

The French Order of Licensed Surveyors (www.geometre-expert.fr) represents licensed surveyors: it negotiates with governmental or other authorities; it also monitors the practice of the profession and defends its moral interests.

The Order is overseen by a higher council, by its 18 regional councils (including the overseas administrative departments of France), and by a commissioner designated by the government. The practice of the profession is organized by law, and the title "licensed surveyor" (Géomètre-Expert, in French) is protected. French Licensed surveyors must be registered with the Order of Licensed Surveyors; they hold a professional card proving their registration with the Order. Currently, there are approximately 1900 licensed surveyors in France. They are trained as engineers and work as liberal practitioners.

4. A FEW WORDS ABOUT GPS PROCEDURES

Geographic information has always had an important impact on all aspects of our civilization. Today, all databases, whether they pertain to land development, environment, security or sociological research, are based on information that is, by definition, related to a geographic location. It has quickly become evident for the users that the association with one single geographic reference made it possible to exchange and take full advantage of the broad diversity of production in all fields.
Of course, the GPS technique has provided the basic tools for locating information, while offering operative modes providing services ranging from cursory precision (within 5 to 10 m for the small hiking receiver) to millimetre precision (for scientific applications).
In order to gain precision, however, it is necessary to work with a differential technique, which implies using two receivers: one being fixed on a point determined by coordinates, and the other mobile, and set on the points to be identified. With two receivers picking up messages from the same satellites, it is possible to overcome error margins, and attain great precision by calculating the difference between the two blocks of data.
This technique for position determination through differential calculation was enhanced by real-time technology, in which the fixed receiver transmits a stream of corrected data to the mobile receiver via GSM or radio. The correction module corresponds to the difference between the approximate position and the precise position, which the fixed receiver can calculate, since by definition it is located at a known point. The mobile receiver then has only to apply this module to its own data to obtain a position determination that can reach the centimetre accuracy.
The principle of a network of permanent stations extends this approach, since it enables a central computing centre to gather messages received by all stations equally distributed over a given territory by means of fixed communication lines, to calculate correction modules by geographic region and to distribute them to the mobile receivers connected to it via GSM or GPRS. The network thus fills the role of the fixed receiver for all potential users who wish to obtain precise positioning and reliability over longer distances.

5. DESCRIPTION OF TERIA

As for multi-station network management software, the market offers two standard products, namely the VRS system called GPSNET from Terrasat-Trimble and the FKP system called GNSMART from Geo++.

The VRS system is based on the following principle :

- The rover sends the approximate coordinates of his NMEA navigated position to the server center via GSM or GPRS.
- We know that the differential corrections take into account the atmospheric and tropospheric elements of the work zone. These corrections vary with the distance separating the transmitting fixed receiver and the mobile receiver. After locating its user, the network calculates the corrections that would be transmitted by a station near the user and transmits them in return via GSM or GPRS. This station, which has no physical embodiment, is called "virtual."

The FKP (Area Correction Parameters, in German : Flächen Korrektur Parameter) system is based on a different process. With the use of FKP, the distance-dependant errors can be predicted for the rover's approximate position leading to increased RTK positionning performance in accuracy and reliability.
As well as in the upper one, the rover sends its NMEA navigated position to the central server. The central software will identify the nearest reference station and send FKP messages through the GSM or GPRS to the rover. The rover will then interpolate the relevant area corrections from the FKP message and apply them to the received RTK messages.

OGE chose the FKP concept from Geo++ because its more rigorous state space approach yields greater performance, in terms of measurements redundancy and resistance to biased model estimates.

6. OGE'S INVOLVEMENT

It should be underlined that the OGE higher council had adopted, from the start, a stance of voluntary participation in the project, even before initiating a consultation with the OGE members. Its first endeavour was to launch the Biarritz pilot project:

7. THE BIARRITZ PILOT PROJECT

A pilot project took place in Biarritz in 2001, allowing OGE to identify difficulties related to the practical application of real-time corrected data transmission. Several tests were conducted to determine the quality deterioration in the results according to the variation in distance between mobile and permanent stations.
It thus became evident that:
- The results quality was ensured without any problems up to a distance of 20 km.
- At more than 20 km distance (although consistent results were obtained at 50 km), quality is more uncertain and requires time and money consuming verification procedures.

Above all, the pilot project demonstrated that:
- Each mobile receiver unit generates its own series of position determination errors;
- That as a result, national coverage based on an increased number of independent stations, each one with a 20 km autonomy, undeniably increased the margin of error for each station. Under such conditions, it seemed impossible to obtain a consistent accuracy throughout the country.

The idea of establishing a "virtual" network offered a solution to this problem:
- The establishment of a permanent network required much less stations (i.e. approximately 100), and was therefore economically attainable.
- Because of one single reference, all the data produced was internally consistent.
- The general production of data is much more accurate. Indeed, the network management software calculates, in terms of corrections, first a status model, which is a model that takes into account the data from all stations in the country, then it adds more local components, such that together it overcomes errors related to distance and produces highly reliable results.

8. OGE'S PARTNERS

The partner we have chosen **Thales, Martec Tekelec Services and Geo++**, is a European consortium with French and German contributions. It has a very strong reputation in the field of communication networking.
This partner will be the network's contractor for the next five years, providing maintenance and technical relations with the clientele, with its top priority being an obligation to perform, which means a guarantee that it will enable users throughout the country to obtain positioning to the centimetre, or from 0 to 5 cm in three dimensions.

9. REAL TIME TECHNOLOGY

Regarding the user's equipment, TERIA will supply corrections in a standard exchange format (RTCM), which means that it will be available for all brands of receivers, provided that they have a dual frequency and of belong to a recent generation (real-time technology less than five years old).

Real-time is indispensable for dynamic applications that cannot rely solely on deferred time technology, as well as for traditional positioning applications, since it is the only technology consistent with economic profitability.
The following applications are concerned:
- Oversight of high-risk work sites
- Topography, photogrammetry
- Guiding public works vehicles
- Precision dredging and bathymetry
- Underground network maintenance
- Geographic Information Systems maintenance
- Precision agriculture or controlled agriculture (input management)
- Farming enterprise management (corn growing, wine grape growing, etc.)
- Fleet management
- Emergency response (public safety, etc.)
- Control automation

Concerning the crux of the Licensed Surveyors' duty, in other words, i.e. delimitation of real estate boundaries, it will very soon become mandatory to associate all boundaries and demarcations. The profession will then be able to provide the country with digital, legal, geographically-referenced information that guarantees real estate limits and ownership.
A change in working methods is inherent to changes in data production demand. Since all data must now be included in geographic information systems and since it must be associated with a single reference (RGF 93), the network is primarily a tool that will enable the profession to modernize its response to changes in demand without being financially prohibitive.

When they first came out, computers and measurement devices using electromagnetic waves were fundamental turning points in the practice of this profession.

The arrival of GPS also substantially changed the approach to construction site production, but it could only be used occasionally until now. Now that it is mandatory to have association with a national reference throughout France, it has become critical to promote resource sharing in order to establish a tool so that the entire profession can fulfil this role.

10. TERIA AND OTHER EXPERIENCES

Many countries have already been using this type of network, or will be using one very soon.
In Europe, there is the FLEPOS network in Belgium, SAPOS and ASCOS in Germany, Agnès and Swissat in Switzerland and ICC in Spain. Great Britain, Sweden, Finland, Austria, Serbia and Portugal have also recently established networks.
As for technical network management software, it is based on one of the two standard products on the market, namely the VRS product from Terrasat-Trimble and the Gnsmart product from Geo++.
The OGE's network uses the FKP concept from Geo++ with an effort to optimise the number of stations.

Most networks are public and some are managed by private structures. They offer an architecture based on a more or less dense number of stations. But TERIA will be, to our knowledge, the only national GPS permanent network completely own and run by a surveyors' professional organization. It is also established in a private public partnership spirit, since it is established in full cooperation (including with regards to technical aspects) with the French mapping agency (IGN), with the French Cadastre Agency, as well as with major French towns.

Till now, nearly 650 Licensed Surveyors have agreed to contribute financially to creation of TERIA. This network will be the property of the profession and all the reference stations involved in its functioning will be its property. It is, however, possible for already existing stations which belong to local governments, schools or public administrations to be connected to the TERIA server, provided there is technical compatibility. In this case, partnership agreements will be signed with the OGE. On the other hand, the use of the network will be open to all users, in exchange of a fee.

11. BENEFITS FOR FRANCE'S ECONOMY AND CITIZENS

The advantages may be categorized into two specific fields:

- Regarding position determination by deferred time calculation, it is important to keep in mind that IGN manages a network of nearly 44 permanent stations on the Permanent Geodetic Network, which allows a user to download data from Internet, free of charge, from the station(s) he(she) would choose, to combine it with data from one's own mobile receiver, and then make a post-processing positioning calculation using the differential method. This IGN network is currently widely used for scientific applications in France and throughout Europe (tectonics, meteorology, etc.) and also for traditional applications related to the RGF 93. On the other hand, it is not equally distributed throughout France, which makes it take longer to use in regions with less coverage.
  OGE's TERIA is planned to provide data from all of its stations (minimum of 1 station per department, i.e. a total of about 100 stations) to the RGP without charge. This will fix the inadequacies that have been noticed so far.

- Regarding real-time positioning, beyond the technical applications mentioned above, it seems evident that new applications will emerge. The network established by the OGE integrates seamlessly into the Galileo system, as it is already an integration tool for the current satellite potential and it plays the role of interface between the satellites and the user. Over the next five years, we expect a profusion of application proposals from manufacturers, since communication technology is progressing very rapidly at the same time.
  It is clear that real-time positioning to the centimetre may be included in common consumer applications, particularly in the field of public safety.

BIOGRAPHICAL NOTES

Alain Gaudet, INSA engineer, has been a licensed surveyor at Clermont-Ferrand since 1974. President of the French Licensed Surveyor Association council of the Auvergne-Limousin region since 2001, he was elected successively member (1991), paymaster (1993 – 1997), vice-president (1997-2001) and president of the French Licensed Surveyor Order on June 17, 2003.
He has committed himself to promote the profession towards its various audiences and to lead substantial projects such as the creation of a permanent GPS station reference network covering the entire French territory. This project will be fully implemented by the end of 2005 and to date mobilizes a third of the French surveyors. In fact, more than 600 Licensed Surveyors are already shareholders of the project.

Jean Cedric Landry is established as a licensed surveyor in the city of Caen (Normandy), since 1999. He graduated from the Paris based Ecole Spéciale des Travaux Publics, and completed his engineering training with a master in business administration, obtained in 1998, and another in urban planning, in 2001. He specialized in urban development, and is an active member of the Ordre des Geometres Experts (OGE) committee on urban planning. He was

the youngest member of the Higher Council of the OGE to be ever elected; he is in charge of the international relations of the OGE, which he has represented in a number of FIG and CLGE meetings.

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