12 Years of the Mexican National Active Geodetic Network

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SUMMARY

Mexico is a nation who based its development in information, in February 1992 through the National Institute of Statistics, Geography and Informatics (**INEGI**), put in operation the National Active Geodetic Network (Red Geodésica Nacional Activa, RGNA), which is the fundamental infrastructure of the country for all kind of geodetic works. To the date, RGNA is a set of 15 stations of continuous operation reference stations of the signal of NAVSTAR satellites. This contribution shows the results that after 12 years of operation has been has, as well as the plan for its modernizations

RESUMEN

México es una nación que basa su desarrollo en información, en febrero de 1992 a través del Instituto Nacional de Estadística, Geografía e Informática (**INEGI**), puso en operación la Red Geodésica Nacional Activa, (RGNA), la cual es la base fundamental para toda clase de levantamiento geodésico en el país. A la fecha la RGNA es un conjunto de 15 estaciones de referencia de operación continua de la señal de los satélites NAVSTAR. Esta contribución muestra los resultados que después de 12 años de operación se han tenido, así como los planes futuros para su modernización.

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1. INTRODUCTION

Mexico is a nation who based its development in information. The National Institute of Statistics, Geography and Informatics, (*INEGI*) is the mexican oficial body, in charge to elaborate all geodetic and cartographic officials products of the country.

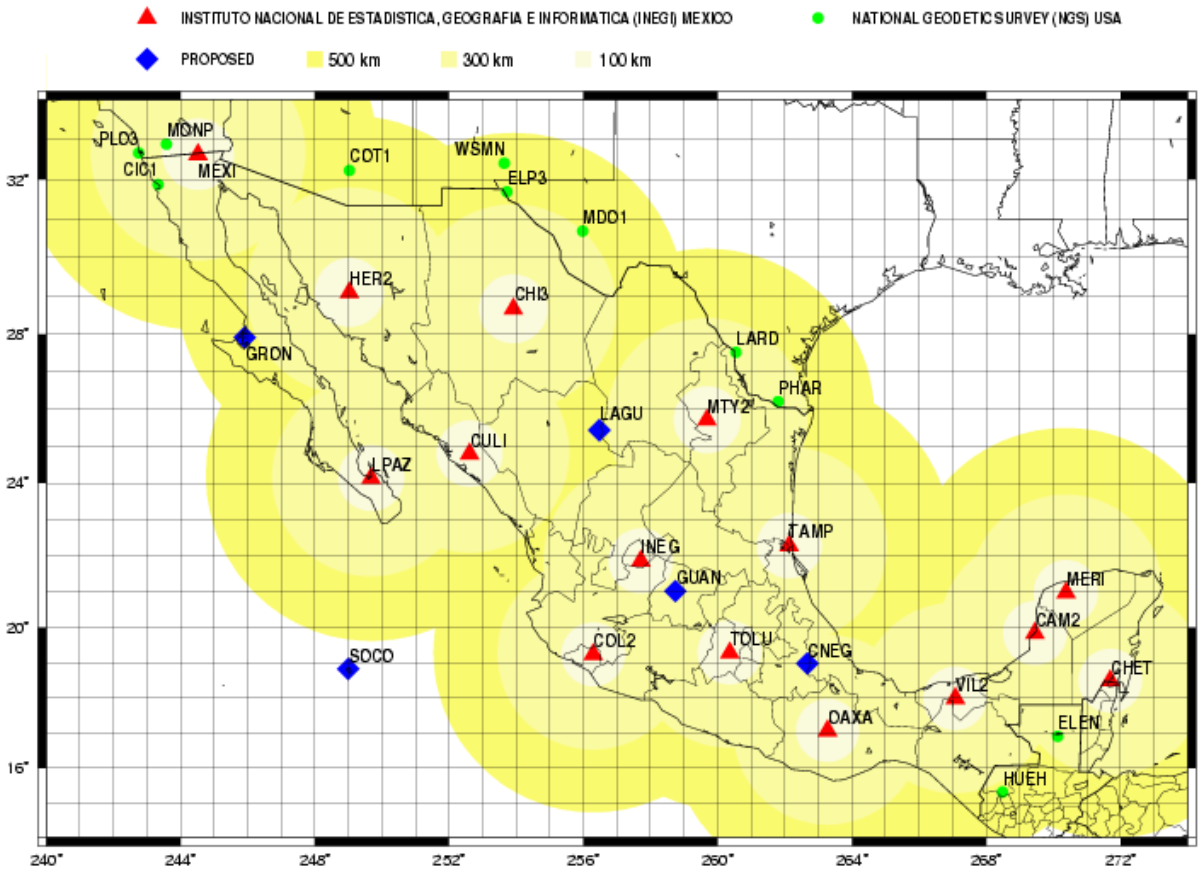

Figure 1. National Active Geodetic Network RGNA

Consequently, INEGI has established a national GPS network of high precision, referred to the frame control defined by the International Earth Rotation Service/International Terresrtial Reference Frame (IERS/ITRF). Bound to this geocentric frame 15 continuous tracking GPS stations are had, which receive the name of National Active Geodetic Network (Red Geodésica Nacional Activa, RGNA) (Figure 1). The position of these stations helps to materialize the frame of space reference, as well as to serve in the propagation of the coordinates to any other observation position. One of the principal goals of the RGNA is to serve as the backbone to the recent jobs for create the system of rural cadastre (PROCEDE). The objectives of PROCEDE, look for to generate pertinent the cartographic evidence that

bases the legal transference of the property to the Mexican rural lands. This information is kept in a cartographic data base consistent with the ITRF, which is the base for all cartographic products of the INEGI.
To almost twelve years of the putting in operation in Mexico of RGNA [Hernandez, A. and Cortes, J.M.; 1996], is time to make some reflections that contribute to evaluate served given by the 15 stations of continuous reference stations that conform it, which settled down within the order of precision of 1:10 000 000, equivalent to the order A of the propose norms by the National Geodetic Survey of United States of America [FGCC, 1988].
The criterion followed for the establishment of the 15 stations, was to assure the national coverage, so that any point located within the Mexican continental area had access to the information of at least one station of the network. For such effects a coverage radius of 500 kilometers by station was selected. This length was determined that allows to the information processing with conventional methods and commercial programs of calculation of reliable way. In Table 1, are shown the geodetic coordinates of these stations referred to the ITRF92 epoch 1988.0, and the GRS80 as geodetic reference system [Soler et al, 1988].

2. THE SERVICE

The intention to have a control system agreed with the requirements of the time, is to contribute a frame of uniform reference for the coordination of all the activities of geodetic surveyings within a certain area. Although it is possible to make measurements without or with little control points, the experience has demonstrated that the lack of an suitable system of reference, can mean in the long run an increase in the costs and difficulties in the rises.
If we made an analysis of the results obtained by the RGNA we will give account of the guessed right decision to put in operation this innovating way to bind the rises to a geodesic system of reference, practitioner and with a high degree of trustworthiness. Thus, it is possible to comment that the service granted by the RGNA to its users has surpassed all its expectations, thus obtaining, to consolidate as the best alternative to bind the geodetic surveying to a reference frame that fulfills the expectations of the more modern methods of measurement.
Making account of its more important activities from January 1995 to the 31 of December of 2003, we have for example that the demand of information from the fixed stations has reached the impressive amount of 1’024,438 GPS data hours. In order to give us an idea of the volume of information handled by the RGNA, we can make the resemblance with the imaginary fact have a single receiver working by 42684.9 days (116.9 years) of uninterrupted way.
It is possible to mention that the INEGI has raised to the date more than 63.000 geodetic points of first order (1:50,000 [SHCP, 1998]), of which they have passed through a process of revision and the integration to a data base more than 58,000 geodetic points, whose coordinates and sketches of location have made available of the users. Table 2 show the amount of first order points in each Mexican state and Figure 2 depicted their spatial distribution.

Station name	North latitude (° ‘ “)	West longitude (° ‘ “)	Geodetic height (m)	Antenna vertical height (m)
CAM2	19 50 39.93767	90 32 24.58870	12.191	0.1440
CHET	18 29 42.99542	88 17 57.20162	3.0126	0.1473
CHI3	28 39 43.89732	106 05 12.25225	1413.1851	0.2570
COL2	19 14 40.00225	103 42 06.77207	528.8403	0.1696
CULI	24 47 54.79178	107 23 02.18514	75.4503	0.1473
HER2	29 05 33.17336	110 58 01.96439	186.9589	0.2224
INEG	21 51 22.15474	102 17 03.12524	1888.316	0.1805
LPAZ	24 08 19.66904	110 19 09.63570	-7.215	0.1326
MERI	20 58 48.16279	89 37 13.13418	7.9119	0.1352
MEXI	32 37 58.76806	115 28 32.51529	-22.4206	0.1488
MTY2	25 42 55.82609	100 18 46.45205	521.7806	0.1410
OAXA	17 04 49.63916	96 43 09.50761	1595.7600	0.1540
TAMP	22 16 41.95723	97 51 50.48937	21.1075	0.1640
TOL2	19 17 35.64431	99 38 36.49337	2651.725	0.1520
VIL2	17 59 25.47706	92 55 51.94738	27.7200	0.1360

Table 1. Geodetic coordinates of the continuous tracking GPS stations

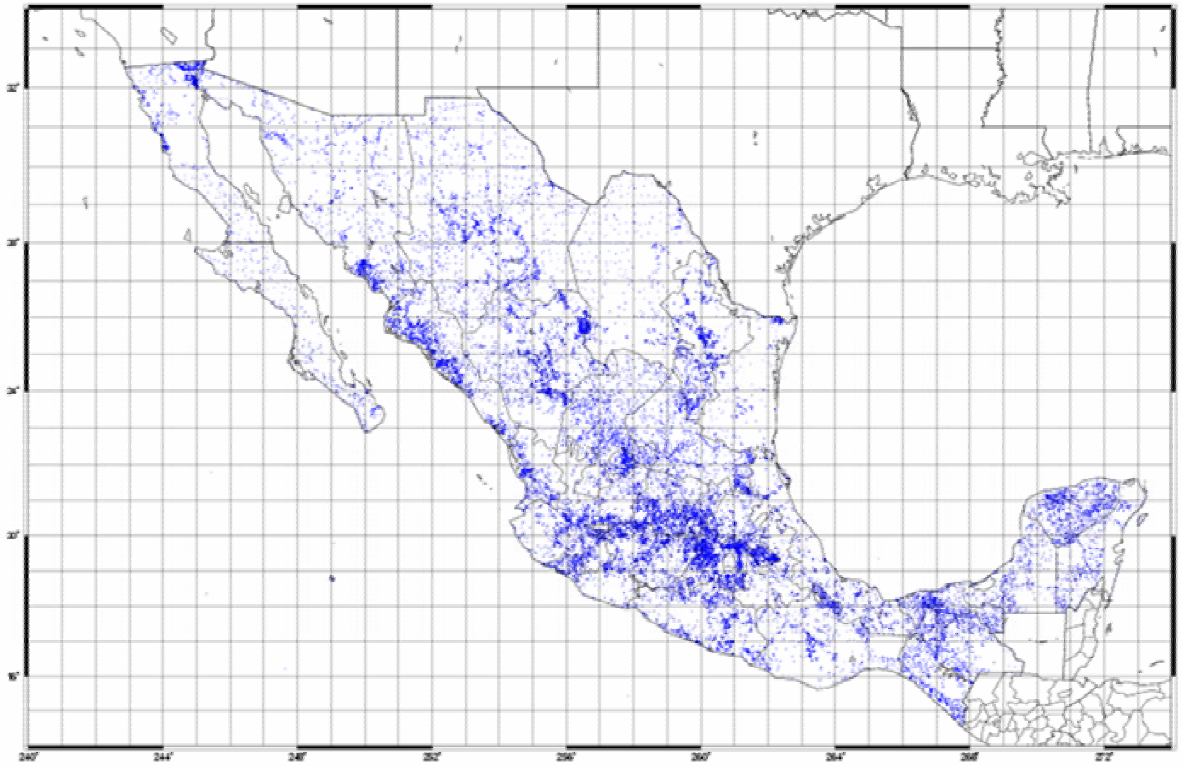

Figure 2. First order network

3. DISTRIBUTION OF THE INFORMATION

INEGI conscious of the important function that the RGNA is in the development of the geodesic activity in our country carries out, has occurred to the task of finding a timing gear that makes get from opportune way the information at its end users. For it, it has been perfecting his means of shipment in the measurement in which it has been possible to have them.

Aguascalientes	734	Morelos	614
Baja California	1463	Nayarit	918
Baja California Sur	623	Nuevo Leon	2029
Campeche	862	Oaxaca	1720
Coahuila	717	Puebla	1327
Colima	532	Queretaro	1018
Chiapas	2056	Quintana Roo	705
Chihuahua	3070	San Luis Potosi	1624
Distrito Federal	127	Sinaloa	2616
Durango	3848	Sonora	2491
Estado de Mexico	3671	Tabasco	1618
Guanajuato	2039	Tamaulipas	526
Guerrero	2355	Tlaxcala	945
Hidalgo	1519	Veracruz	6492
Jalisco	2735	Yucatan	2063
Michoacan	3071	Zacatecas	2006

Table 2. First order points

At the begin of the service, the internal user solicited via telephone, fax or personally the archives of determined date and hour to the person in charge of the service at the continuous tracking GPS stations, who located the files and sent them, by postal mail service mainly, being with the inconvenience of which the information was given to the user at least five days after it was deposited in the mail service, this process was time consumption and the information could not be send in a fast way.
Given the evident difficulties that that mechanism presented, a new procedure of distribution was established by means of a serve, located in the INEGI's Automated Mapping Centers, and making use of INEGI's telecommunications network. In this server, the observation, navigation, and message files are centralize, which is a fastest and efficient way to gave the service since it is possible to be had them immediately, this procedure consists basically of the following thing:

The information of a day, that it consists of 27 files (24 of data with one hour of observations, one file of navigation data, one file of GPS message, and one with

comments) is deposited in the central server, being located in a directory associated to the date of registry and that is available during 90 days.

Figure 3. Scheme of deposit and consulting of RGNA's data

The internal users have immediate availability of the archives through INEGI's LAN and WAN. Meanwhile the external users ask for archives through the Information and Sales INEGI's centers.

4. THE FUTURE

In the near future, INEGI will implement an Internet server by means of which access to the information generated in the RGNA stations will be had, providing greater speed of transmission, better quality and service to all its users in a "open data policy". In addition to the availability and immediate selection of the archives the following characteristics would be had:

Direct connection (RGNA station to the server) from all the stations and State and Regional INEGI's offices.

The external users will be able to have access to the information through a personal computer with Internet connection and also through the Information and Sales Centers that INEGI has in the whole country . The purpose is that this information will be free of charge to the end user while the data files are in the server. After the 90 available days, the data files will had been a minimal cost.

Actually INEGI, counts with four additional equipment to reinforce the operation of the network (see Figure 1), as well as are looking for strategic alliances with other generators of geodetic information to conform a partnership to fortify the geodetic activity at national level. Also, we are analyzing the possibility to broadcast differential correction to improve real time navigation.

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BIOGRAPHICAL NOTES

Antonio Hernández-Navarro has a bachelor in Surveying and Geodetic Engineering from the National Autonomous University of Mexico. Since 1980 has been work at the Mexican National Institute of Statistics, Geography and Informatics always involved in geodetic activities

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