THE GNSS NETWORK OF TUNISIA
FIG Working Week 2011
Bridging the Gap between Cultures
Marrakech, Morocco, 18-22 May 2011

Kamel NAOUALI
Chief of the Geodesy Division
Office de la Topographie et du Cadastre
Tunisia
Kamel.naouali@planet.tn
GSM (+216)98586359

CONTENTS

- Introduction
- GNSS Network
- Connection of GNSS stations to the IGS Network (ITRF 2000)
- Statistical Analysis
- Future Prospects
INTRODUCTION

CURRENT STATUS OF THE GNSS NETWORK OF TUNISIA

Since 2005, the TCO (Topographic and Cadastre Office) has installed three GNSS stations at Tunis, Monastir and Sfax.

During this year, the TCO undertakes the covering of the Tunisian territory by others GNSS stations (20).
Each station is equipped with:

- A radio transmission module
- A GSM transmission module
- A weather sensor (Temperature and Pressure)
- A tilt sensor (Tilt meter)

These stations record daily files of 30 seconds and one second.

Files stations Monastir and Sfax are transmitted to Tunis via FTP (File Transfer Protocol).
The coordinates are calculated daily with stations connected to the IGS network (ANKR, EBRE, GRAS, MATE, RABT and SFER). These calculations have permitted to obtain the precise coordinates of the three stations.
Connection of GNSS stations to the IGS Network

Reliability Technology

The reliability of permanent GPS stations is proven.

However, a statistical analysis was performed to confirm the accuracy provided by the use of technology GNSS permanent stations.
Statistical Analysis

Theoretical aspect

Normal distribution (Gauss curve):
Density function of a normal probability distribution with mean $m$ and a standard deviation $\sigma$

$$y = f(x) = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{(x-m)^2}{2\sigma^2}}$$

$$y_{max} = \frac{1}{\sigma \sqrt{2\pi}}$$

The certainty of a solution can be quantified by its standard deviation or a probability, eg:

- A standard deviation $1\sigma$ \rightarrow a probability of 68.3%
- A standard deviation $2\sigma$ \rightarrow a probability of 95%
- A standard deviation $3\sigma$ \rightarrow a probability of 99.73%
Practical Aspect

Station as an example TUNIS

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>rms</td>
<td>mean</td>
</tr>
<tr>
<td>Tunis</td>
<td>53.2451</td>
<td>0.0068</td>
<td>53.2451</td>
</tr>
<tr>
<td>Monastir</td>
<td>54.0589</td>
<td>0.0082</td>
<td>44.7745</td>
</tr>
<tr>
<td>Sfax</td>
<td>66.6058</td>
<td>0.0082</td>
<td>78.0268</td>
</tr>
</tbody>
</table>

The Geocentric Coordinates

\[ X = 5030053.2451 \, m \]
\[ Y = 904828.1546 \, m \]
\[ Z = 3803130.3654 \, m \]

We took a sample of 67 days of observations from GPS week 1342 to GPS week 1351.
We have the following values:

Mean = 53.2451 m
standard deviation = 0.0068 m

The accuracy obtained for the measured data is:

\[ \text{Accuracy} = \frac{\text{standard deviation}}{\sqrt{\text{number of samples}}} \]

\[ = \frac{0.0068}{\sqrt{67}} = 0.0008 \text{ m} \]
Correlation between the coordinates X, Y and Z of the station of Tunis

The study of deviations allowed us to determine the coefficients of correlation between the coordinates of the station of Tunis.

The same work is done for the stations of Monastir and Sfax.
The coordinates determinated in m of the three stations are:

**TUNIS**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>5030053.2451</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>904828.1546</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>3803130.3654</td>
<td></td>
</tr>
</tbody>
</table>

**MONASTIR**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>5088454.0589</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>973044.7745</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>3708041.8522</td>
<td></td>
</tr>
</tbody>
</table>

**SFAX**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>5155566.6058</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>978978.0268</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>3613172.0665</td>
<td></td>
</tr>
</tbody>
</table>

Future Prospects

On this map are reported the twenty three existing stations.
- Installation of twenty (20) permanents stations in 2010 to cover the northern and central area of the territory of Tunisia.

- Then extend the project to cover the whole country during the year 2011.

- Installation of stations according to the specifications IGS,

- Working under the strict rules of international standards (RTCM, RINEX NMEA).

- Adoption of a scalable architecture for the network to take into account the constant changes that knows the field of spatial positioning.

- Responding to the growing needs of users for more interoperability, reliability and accuracy.
- Ensure data quality control.
- Choosing a real-time network, at least in areas of high urban density and this means using all existing transmission: Radio (UHF), GSM / GPRS.
- Track changes and update the regulations of the GNSS NETWORK.

- To ensure the transmission of data in real time or post-treatment (post data on a website dedicated to RGPT).
- Provide all information on network status, available data, conversion utilities and quality control to users according to protocols OTC - users.
Having adopted a terrestrial reference only, make the gradual transition to this new datum reference (it is possible to have two systems provided to make available forms of transition between two completely reversible).

The End!
Thanks for listening