Status of the International GPS Service in Terms of Co-Location and Local Ties

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1 Introduction

The IGS network today consists of 364 stations (see Figure 1) managed by about 100 different agencies worldwide. The RINEX observations are contributed (generally on a daily or hourly basis) to the IGS Data Centers, which permanently archive the data and make it freely available to all users. The primary customer of the data set is the IGS Analysis Centers (ACs), which acquire the data for generation of precise GPS products such as ephemerides, clocks, earth orientation parameters, and station positions and velocities. The IGS Network Coordinator (NC) at the Central Bureau acts as liaison between the station operators and the Analysis Centers, collecting and providing necessary station configuration metadata and ensuring the dataset meets the requirements of the analysis.

As noted in other presentation at the Matera Co-Location Workshop, GPS differs from the other geodetic services in this abundance of sites, owing mainly to the relative ease of installation and operation. The IGS values inclusiveness and has historically accepted any site meeting the technical requirements. However, in recent years the network has reached quite satisfactory levels of coverage and redundancy in some areas, which tends to lead to fewer independent analyses of neighboring sites. As an initial measure to control the station population, proposed sites are now asked to state which IGS product or project would benefit from the addition of that site. In some areas, sites can be referred to regional densification networks such as the EUREF permanent network in Europe.

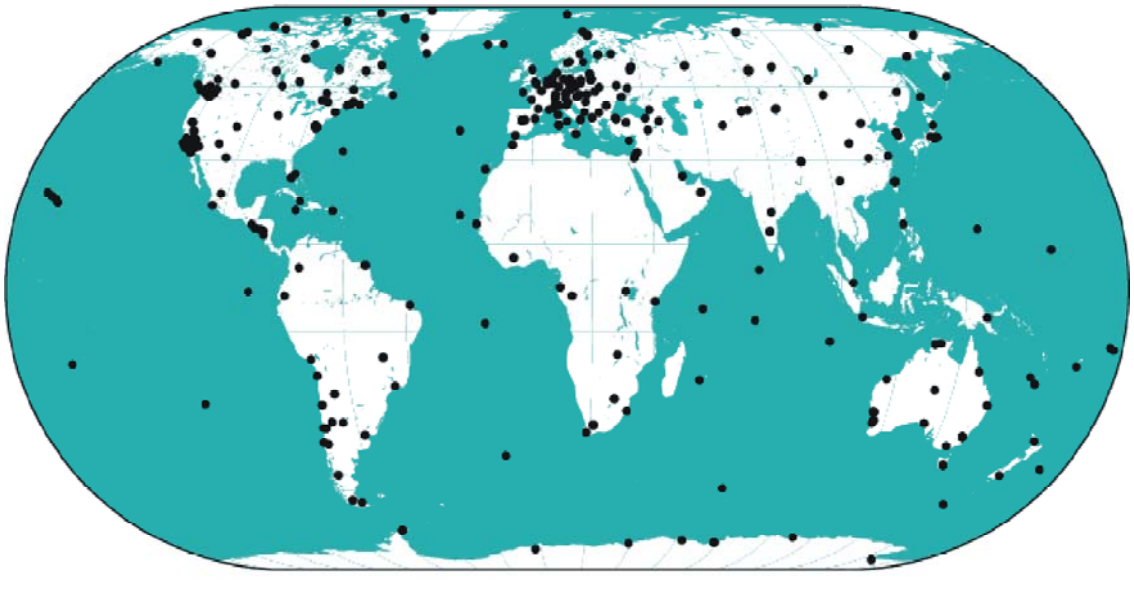

Fig 1 The IGS Tracking network

It should be noted that some areas do still suffer from sparse coverage. The IGS is active in some special efforts to encourage use of geodetic GPS, such as the IAG's AFREF project to establish a continental reference frame for Africa.

2 Site Metadata in the IGS

The IGS requires an up-to-date "site log" (also known as "site information form") for each site. The latest format[1] for site logs was devised through community discussion in late 2001 and all site logs were moved to this format in mid-2002.

The IGS "SINEX template"[2] is generated daily at the Central Bureau from official site logs and is the official site metadata set which ACs are requested to use. Included for each site in this file are

- IERS DOMES numbers
- Receiver model and serial numbers, and firmware version
- Antenna model and serial numbers
- Radome type
- Antenna Reference Point → L1 and L2 phase center offsets as defined for that antenna model in the igs_01.pcv file
- Marker → Antenna Reference Point eccentricities

for both current and past time periods. The data in these areas of the site log undergo considerably scrutiny by automatic software processes as well as by the NC.

A "Surveyed Local Tie" section was in fact added to the latest version of the site log format, as demonstrated in Figure 2. There was some discussion on whether one geodetic service is the proper place for local tie information to be assembled, but consensus was that there was no harm in providing the spot to being collecting the data, pending formulation of other plans for local ties in the community.

3 Site Guidelines

A major effort to revamp the IGS Site Guidelines was undertaken in 2003. Experience suggested that operators would appreciate a clear delineation of strict requirements vs. additionally desired characteristics. Also, guidelines are separated out for specific subsets of sites, such as Reference Frame sites, which are determined by the IGS Reference Frame Working Group (chaired by R. Ferland of NRCan). Up to now, the selection process has been informal, but the new guidelines bring the possibility to point operators of the Reference Frame stations to the relevant sections and request confirmation of the ability to adhere to them.

[1] ftp://igscb.jpl.nasa.gov/pub/station/general/blank.log
[2] ftp://igscb.jpl.nasa.gov/pub/station/general/igs.snx

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5.    Surveyed Local Ties

5.1   Tied Marker Name                 : MATE
      Tied Marker Usage                : GPS Tied Marker CDP Number :
      Tied Marker DOMES Number         : 12734M008
      Differential Components from GNSS Marker to the tied monument
                                       (ITRS)
                  dx (m)               :
                  dy (m)               :
                  dz (m)               :
                  Accuracy (mm)        :
            Survey method              : (GPS Campaign/Trilateration/Triangulation/etc)
            Date Measured              : 1991-09-01
      Additional Information           : (multiple lines)
                                       : UP (m)
                                       : EAST (m)
                                       : NORTH (m)
                                       : DIST (m)
                                       : exact date in Sep 1991 not known
5.2   Tied Marker Name                 : SLR (MARKER O)
      Tied Marker Usage                : SLR
      Tied Marker CDP Number           : 7939
      Tied Marker DOMES Number         : 12734S001
      Differential Components from GNSS Marker to the tied monument
                                       (ITRS)
                  dx (m)               : 15.172
                  dy (m)               : 24.826
                  dz (m)               : -24.959
                  Accuracy (mm)        : 2
                  Survey method        : TRIANGULATION
                  Date Measured        : 1996-07-01
      Additional Information           :

5.3   Tied Marker Name                 : VLBI
      Tied Marker Usage                : VLBI Tied Marker
      CDP Number                       : 7243
      Tied Marker DOMES Number         : 12734S005
      Differential Components from GNSS Marker to the tied monument
                                       (ITRS)
                  dx (m)               : -10.946
                  dy (m)               : -42.246
                  dz (m)               : 38.203
                  Accuracy (mm)        : 6
                  Survey method        : TRIANGULATION
                  Date Measured        : 1991-11-01
      Additional Information :
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Figure 2: Sample of Local Tie information in an IGS site log

Items specific to local ties and reference frame determination in the current version[3] include:

2.2.17 (desired for all sites): 3-dimensional local ties between the GPS marker, collocated instrumentation (e.g. DORIS, SLR, VLBI, gravity, tide gauge) and other monuments should be re-surveyed regularly to an accuracy of 1mm and reported in ITRF.

- The marker → antenna reference point (ARP) eccentricities should be reverified during such a survey.
- Repeat the survey after known motion incidents such as earthquakes.

3.1 About Reference Frame Sites: The IGS Reference Frame Working Group (RFWG) periodically selects a set of globally distributed, stable sites to be used in reference frame determination. Excellent documentation of site history is particularly critical for these stations, and the station position time series must be free of jumps whose cause or magnitude is not well understood. All IGS products rely on the reference frame to be accurate, reliable, and stable.

The RFWG has the expertise to weigh station locations and characteristics in choosing the Reference Frame station set. Although there is some motivation to keep stations from one realization of the frame to the next, stations may be removed or replaced as the WG sees fit. All the required and desired guidelines from Chapter 2, Guidelines for all IGS sites are equally, and even more so, required and desired for Reference Frame sites. The characteristics from Section 2.3, "Desired physical characteristics" are also all considered in the selection process and highly desirable. The degree of compliance in many cases will have an effect on time series, residuals, and velocity estimates important to frame determination.

3.2 Additional Reference Frame Site Selection Criteria: The RFWG will also weigh the following criteria in selecting reference frame sites.

- Significant distance from the nearest reference frame station
- For coordinates and velocities useful to Reference Frame determination, sufficient observing history is needed (usually >2 years)
- Operated by an institution with a long-term commitment and geodetic expertise
- Relation to regional/national geodetic network, if one exists
- Likelihood of site being abandoned or overtaken by other uses should be very low
- Consistently high-quality raw data, with good tracking, low multipath, and low quantity of cycle slips
- Priority is given to stations with nearby installations of other space geodetic systems (SLR, VLBI, and DORIS) and which undergo regular surveys

This reflects biennial resurveys for reference frame sites vs. annual as suggested at the Matera Workshop. One option could be to recommend biennial surveys for all sites and require annual surveys for reference frame sites. Care should be taken, however to make requirements and recommendations that are actually reasonable to expect the operators to attain.

The guidelines were approved by the IGS Governing Board with the proviso that a program of continuous review and improvement be also instituted.

[3] http://igscb.jpl.nasa.gov/network/guidelines/guidelines.html or http://igscb.jpl.nasa.gov/network/guidelines/guidelines.pdf

Suggestions for alignment with the IERS community are therefore welcome at any time as the co-location and local tie plans and documents are developed.

4 Acknowledgments

The successes of the IGS network are realized thanks to the efforts of the agencies which install and operate the stations.

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