



IGN activities as IGS data center and GNSS data analysis center

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IGN activities as IGS data center

Introduction

The IGN Global Data Centre (GDC) has been designed and implemented in answer to both the Analysis Centers and the surveying user community requirements, for post-processing and real-time applications. The GNSS observations from all the IGS network stations and from the low earth orbit satellites, as well as the IGS products are archived and available at IGN GDC. The IGN data center is handled by the geodetic and levelling department (SGN) which is the operational service of geodesy of the French national mapping agency. Development and maintenance of the IGS Data Center at IGN is a collaborative effort of the following persons:

- Eric FOURESTIER (eric.fourestier@ign.fr) : computer system administrator,
- Bruno GARAYT (bruno.garayt@ign.fr): engineer in charge of the management and maintenance of the service.

Data Center activities

The following data are routinely uploaded at IGN GDC and available through anonymous FTP access :

- GNSS daily observations for more than 220 IGS sites,
- GNSS hourly observations online during 6 days,
- Analysis Center final products as well as all Analysis Center Combination (AAC) files.

A new web-based interface is under development. It will enable, through a cartographic server, to query :

- Some general information on the stations,
- Extraction and transformation of data.

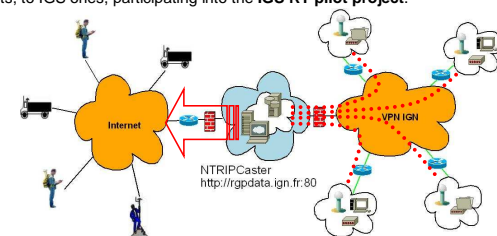
The management of the data center and the web services will be based on a specific database.

Real Time future

In the frame of its IGS activities as a GDC, IGN wants to use the real-time data streams to generate station data files at high rate and usual 30-second files, but also to become a real-time data and products distribution center.

Since last October, IGN operates a NtripCaster at <http://rgpdata.ign.fr:80>. It is registered as a EUREF-IP and IGS-IP caster.

We want now to extend this activity which is taking an increasing part of our general GNSS permanent network projects, to IGS ones, participating into the IGS RT pilot project.



Systems overview

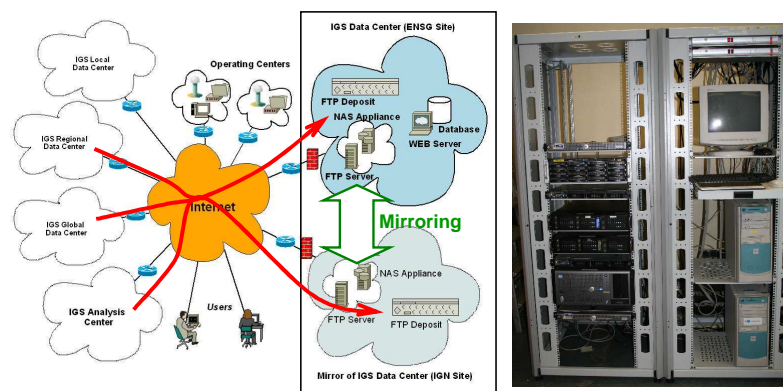
So as to have a more reliable data flow and a better availability of the service, two identical configurations have been setup in two different locations in IGN. Each configuration has :

- FTP deposit server for data and analysis centers uploads,
- Special authentication is necessary to access.
- Please contact the IGN team at igsadm@ensg.ign.fr if you are not registered in.
- FTP anonymous access to the GNSS observations and products,
- Fully independent Internet links.

The two configurations are in mirroring using VPN connexions.

As soon as they are available, GNSS observations and IGS products uploaded at IGN deposit servers by the data and analysis centers are pushed to the public FTP servers.

A mirroring is performed with the other GDCs and between the two IGN sites to complete the archive.



Independent Internet Access

Public servers
DELL PowerEdge server
Bi-processor Intel Xeon Dual-Core
More than 2 GB SDRAM DDR

Network Attached Storage
Digital Storage DNAS server
RAID Controller
Memory space 10 TB

Software

DEBIAN Linux distribution was chose to manage our systems.

To perform mirroring between other data centers we customized a Perl script used by DEBIAN community : "Mirror". This tool was designed to duplicate a directory hierarchy between two machines using FTP protocol. We developed an additional script that permits to schedule "crontab" tasks in answer to the data center requirements. Thanks to package files using regular expressions and a large number of parameters we are able to customize the mirroring behaviour for each data center we work with.

Archive content (GNSS data and product directory structure)

The anonymous ftp servers contain daily, hourly and sub-hourly updated files. They may be access through:

- <ftp://igs.ensg.eu> for the Marne-la-Vallée site
- <ftp://igs.ign.fr> for the Saint-Mandé site

All filenames follow the IGS specifications and are mostly UNIX compressed (extension .Z).

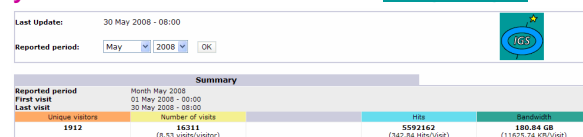
The following abbreviations have been used in the filenames above:

```
ccc Analysis center code
ssss GNSS station code
yy/yyyy Year (2 digits / four digits)
ddd Day of year
mm Minutes of the file beginning
h Hourly session code, from a to x.
```

Information related to the reprocessing campaign are into brackets.

Data	Description	File name	Primary origin of the data	Directory
Weekly Reference frame	Station Positions	ccc0c1[yearw7].ans	IGN deposit server (CDDIS)	/pub/igs/products/
	Sets of Station Coordinates (asc format)	ccc0c1[yearw7].asc	IGN deposit server (CDDIS)	www [repro1]
	Summary	ccc0c1[yearw7].sum	IGN deposit server (CDDIS)	www [repro1]
Final products	Earth Rotation Parameters	ccc0c1[yearw7].erp	IGN deposit server (CDDIS)	www [repro1]
	Precise satellite orbits and clocks	ccc0c1[yearw7].sp3	IGN deposit server (CDDIS)	www [repro1]
	Satellite and station clocks	ccc0c1[yearw7].clk	IGN deposit server (CDDIS)	www [repro1]
Atmospheric products	Final ionospheric TEC grid	ccc0c1[yearw7].ytd	IGN deposit server	/pub/igs/products/
Hourly	GPS & GLONASS observations (Compact Hatanaka RINEX format)	ssssddh.yyyd	IGN deposit server	/pub/igs/data/hourly/yyyyidd
	Broadcast ephemerides	ssssddh.yym	IGN deposit server	
	Meteorological observations	ssssddh.yym	IGN deposit server	
	Meteorological observations	ssssddh.yym	IGN deposit server	
Daily	GPS & GLONASS observations (Compact Hatanaka RINEX format)	ssssdd0.yyyd	IGN deposit server	/pub/igs/data/yyyyidd
	Broadcast ephemerides	ssssdd0.yym	IGN deposit server	
	Broadcast ephemerides	ssssdd0.yym	IGN deposit server	
	Combined broadcast GLONASS ephemerides	bdssdd0.yyy	CDDIS	
	Combined broadcast ephemerides	bdssdd0.yyy	CDDIS	
	Meteorological observations	ssssdd0.yym	IGN deposit server	
	Quality check summaries	ssssdd0.yym	IGN deposit server	
Subhourly high rate	GNSS observations (Compact Hatanaka RINEX format)	ssssddhmm.yyyd	IGN deposit server	/pub/igs/data/highrate/yyyyidd
	Broadcast ephemerides	ssssddhmm.yym	IGN deposit server	
Satellite (LEO)	GPS observations (Compact Hatanaka RINEX format)	ssssdd0.yyyd	CDDIS	/pub/igs/data/satellite/name/yyyyidd
	Quality check summaries	ssssdd0.yym	CDDIS	
IGS cumulative reference frame	Residuals file	IGS[IG]yP[year].res	CDDIS/SIO (CDDIS)	www [repro1]
	Station Positions	IGS[IG]yP[year].ans	CDDIS/SIO (CDDIS)	www [repro1]
	Sets of Station Coordinates (asc format)	IGS[IG]yP[year].asc	CDDIS/SIO (CDDIS)	www [repro1]
IGS weekly reference frame	Earth Rotation Parameters	igs[ig]1[yearw7].erp	CDDIS/SIO (CDDIS)	www [repro1]
	ns file	igs[ig]1[yearw7].ns	CDDIS/SIO (CDDIS)	www [repro1]
	Station Positions	igs[ig]1[yearw7].ans	CDDIS/SIO (CDDIS)	www [repro1]
	Sets of Station Coordinates (asc format)	igs[ig]1[yearw7].asc	CDDIS/SIO (CDDIS)	www [repro1]
	Summary	igs[ig]1[yearw7].sum	CDDIS/SIO (CDDIS)	www [repro1]
	Residuals file	igs[ig]1[yearw7].res	CDDIS/SIO (CDDIS)	www [repro1]
IGS Ultrarapid orbits, erp, ...	Precise satellite orbits and clocks	igrwmmw7.sp3	IGN deposit server	/pub/igs/products/
	Earth rotation parameters	igrwmmw7.erp	IGN deposit server	www
	Summary report	igrwmmw7.sum	IGN deposit server	www
	Comparative summary report	igrwmmw7.comp.sum	IGN deposit server	www
	cumulative Earth Rotation parameters	igrwmmw7.erp	IGN deposit server	www
IGS rapid orbits, clock, erp, ...	Precise satellite orbits and clocks	igs[ig]1[yearw7].sp3	IGN deposit server (CDDIS)	www [repro1]
	5 minute satellite and station clocks	igs[ig]1[yearw7].clk	IGN deposit server (CDDIS)	www [repro1]
	30 seconds satellite and station clocks	igs[ig]1[yearw7].clk	IGN deposit server (CDDIS)	www [repro1]
	Earth Rotation Parameters	igs[ig]1[yearw7].erp	IGN deposit server (CDDIS)	www [repro1]
	Cumulative Earth Rotation parameters	igs[ig]1[yearw7].erp	IGN deposit server (CDDIS)	www [repro1]
	Summary report	igs[ig]1[yearw7].sum	IGN deposit server (CDDIS)	www [repro1]
IGS final orbits, clock, erp, ...	Precise satellite orbits and clocks	igs[ig]1[yearw7].sp3	IGN deposit server (CDDIS)	www [repro1]
	5 minute satellite and station clocks	igs[ig]1[yearw7].clk	IGN deposit server (CDDIS)	www [repro1]
	30 seconds satellite and station clocks	igs[ig]1[yearw7].clk	IGN deposit server (CDDIS)	www [repro1]
	Earth Rotation Parameters	igs[ig]1[yearw7].erp	IGN deposit server (CDDIS)	www [repro1]
	Cumulative Earth Rotation parameters	igs[ig]1[yearw7].erp	IGN deposit server (CDDIS)	www [repro1]
	Summary report	igs[ig]1[yearw7].sum	IGN deposit server (CDDIS)	www [repro1]
IGS GLONASS orbit products	Precise satellite orbits and clocks	igs[ig]1[yearw7].sp3	IGN deposit server	/pub/igs/products/
	Summary report	igs[ig]1[yearw7].sum	IGN deposit server	www
Atmospheric products	Final ionospheric TEC grid	igs[ig]1[yearw7].ytd	IGN deposit server	/pub/igs/products/
	Rapid ionospheric TEC grid	igs[ig]1[yearw7].ytd	IGN deposit server	www
	Daily site zenith path delay	ssssdd0.yyyd	CDDIS/SIO	/pub/igs/products/
	Weekly site zenith path delay	ssssww0.yyyd	CDDIS/SIO	/pub/igs/products/

Monthly statistics of downloaded files : <ftp://igs.ensg.eu>



IGN beginnings as « analysis center »

Introduction

Last year, the IGN service of geodesy (SGN) launched a project whose goal was the production, at IGN, of ultra-rapid, precise GPS orbits and clocks. This development responds to specific internal needs which are not fully fulfilled by IGS products. But it is also a way for IGN to reduce its dependency on external analysis centers.

Even if their production line is not yet completely stabilized, the SGN ultra-rapid products (denoted by the prefix "SGU") have been published since December 2007 on the ftp site [rgpdata.ign.fr](ftp://rgpdata.ign.fr), directory /products/ephemerides. Three files are released every 2 hours:

- an orbit sp3 file covering 24 hours of observations and 24 hours of prediction
- the corresponding Earth rotation parameters file
- a 3 minutes rate RINEX clocks file.

(A 30 seconds rate RINEX clocks file is also expected for soon.)

The origin, the implementation and the first results of the "SGU project" are detailed next.

Why ? – IGN needs for ultra-rapid orbits and clocks

Several causes determined IGN to produce its own analysis products. First, the reason for rapid high-rate clocks stands in the need for rapid validations of the aerial photography flights. Indeed, the flights trajectories are determined by PPP. And rapid computations are needed so as to quickly modify the flights planning when necessary.

Then, releasing products every 2 hours benefits to IGN hourly troposphere estimations: while, using IGS products, a 6 hours cycle was suspected in the quality of results, this cycle is reduced to 2 hours with the SGU products.

IGN also wanted to reduce its dependency on the external analysis centers so as to maintain its production even in case of a failure in one or more of these centers. And finally, this project could be the first step in a new participation of IGN as IGS analysis center.

How ? – The SGU production line

The first step in the design of the SGU production line was the choice of the IGS stations whose data would be analyzed. This choice was made using several criteria:

- For the rapidity of computation, relatively few stations had to be selected (about 50).
- These stations necessarily had to send hourly data.
- They should be spread as regularly as possible over the Earth.
- When possible, their receivers should be driven by an external atomic clock.
- And when possible, they should belong to the IGS05 reference frame sites.

Figure 1 shows the network which was thus designed. It contains 56 primary stations. Some of them have got "replacement stations" (secondary and tertiary stations) which are used when their primary station is not available.

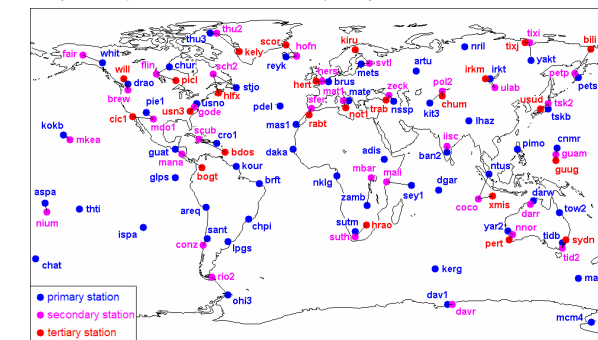


Figure 1: Full stations network used for the SGU computations

Then, the production line itself had to be designed, from the download of hourly observations to the publishing of final SGU products. The core of this production line consists in Fortran programs of the Bernese GPS Software 5.0. These programs are called by Perl scripts which also perform specific actions. The chaining (and parallelization) of these scripts is managed by the Bernese Processing Engine, which is itself called by a Perl master script executed every 2 hours.

Figure 2 presents the main steps of the processing. After downloading and preprocessing the data, a first estimation / integration of orbital elements occurs. Then the process is divided into two parallel parts. On the one hand, iterations of the estimation / integration of orbital elements process are performed, based on L3 double differences. On the other hand, the satellites and receivers clocks are iteratively estimated using undifferenced P3 and L3 observations.

Results – Comparison with IGS and IGU products

On figure 3, the differences between IGU (session 14582_00) and IGS ephemerides are represented by an histogram and compared with the SGU-IGS differences. The chosen session is quite representative of the quality of SGU ephemerides (when the computation does not encounter any trouble...); they are comparable with the IGU ephemerides on their observed part, but of lower precision on their predicted part (possibly due to an inaccurate prediction of ERP?).

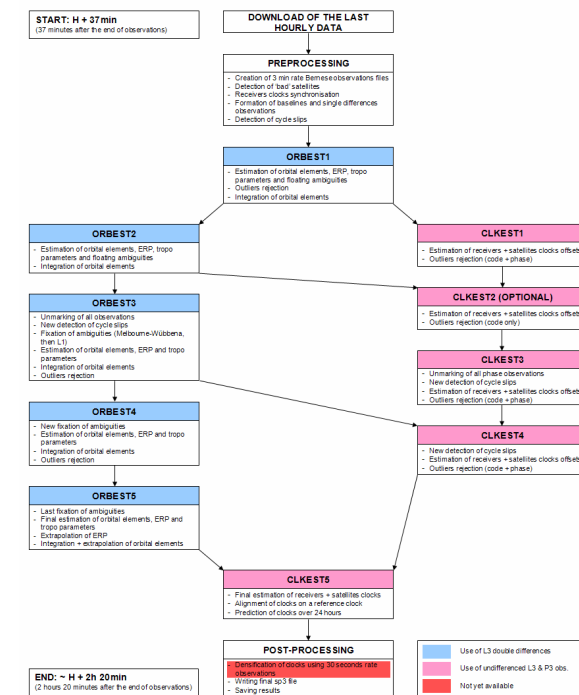


Figure 2: General scheme of the SGU production line

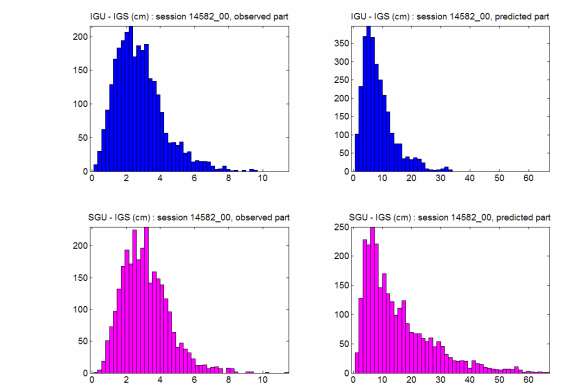


Figure 3: Comparison of IGU and SGU ephemerides with IGS ephemerides

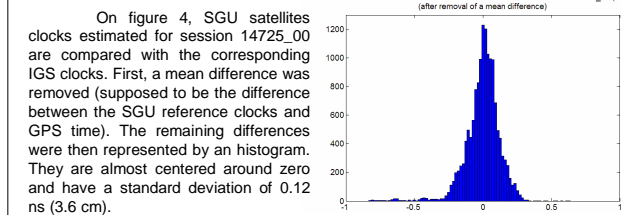


Figure 3: Comparison of SGU and IGS clocks

On figure 4, SGU satellites clocks estimated for session 14725_00 are compared with the corresponding IGS clocks. First, a mean difference was removed (supposed to be the difference between the SGU reference clocks and GPS time). The remaining differences were then represented by an histogram. They are almost centered around zero and have a standard deviation of 0.12 ns (3.6 cm).

Conclusion

First of all, the differences between SGU and IGU products have to be pointed out: SGU ephemerides are published every 2 hours and include a RINEX clocks file. SGU products thus meet their original goals:

- They enable near real-time PPP (at a 10 cm precision according to performed tests).
- They are also supposed to improve IGN hourly troposphere estimations (and more generally any near real-time network process).

However, the SGU production line still needs important improvements on many points: densification of clocks to 30 seconds rate, improvement of the predicted ephemerides and ERP, detection of "bad" stations, become totally independent on CODE analysis center,... And when the production line is stabilized, SGU products will have to go through an external validation.

So IGN is still far away from a participation to IGS as an analysis center. But the production of the SGU ephemerides is still a first step in this way.