ESA/ESOC IGS Network Operations. Present and Future.

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Abstract

The purpose of this paper is to present the evolution and developments of the GNSS network managed and operated by the European Space Operations Centre (ESOC). It starts with an overview of the evolution in the last couple of years since the last IGS Workshop. A description of the current network status follows showing the way that it is supporting the various IGS projects and working groups. The IGS recommendations have a clear impact on the network and some examples are described. The deployment of a network of experimental receivers to track the Giove satellite is the latest and most important event. The plans for the future are described as well.

Introduction

ESA/ESOC has mainly a twofold role in the IGS:

- It is an operational Data Centre contributing data from a small but growing worldwide network of about 12 receivers. They will become almost 20 with the incorporation of the Galileo experimental receivers in the near future.
- On the other hand ESA/ESOC is an Analysis Centre that targets to contribute to all the processing products resulting in the need for almost all kind of data and metadata distributed in IGS.

There is a permanent need to update the stations network with enhancements that fulfil the new requirements from all the IGS groups:

- Data retrieval and availability in real-time, 1 Hz, 15 min NRT, hourly, daily, etc
- New places like Tahiti, needed to improve the coverage of the RT and the GLONASS networks
- Permanent GPS only and GPS/GLONASS receivers acquisition to provide local back-up receivers and improve GLONASS network coverage
- Connection to Hydrogen masers (New Norcia, Cebreros, Kourou planned) or Cesium oscillators (rest of the stations)

ESOC GNSS Network Evolution

The ESOC GNSS network has undertaken a complete overhaul in the last two years with the following main achievements:

- Creation of the Navigation Facility at ESOC to centralise data handling on an operational environment.
- At the stations: racks overhaul following the ESA integration standards and with remote storage of back-up equipment
- Communications integration in an operational network shared with the main ESA projects

With the development of the ESA deep space network the ESA sites are being equipped with very stable Hydrogen masers oscillators. This has presented the chance to connect the GNSS receivers to them. The main locations are:

- New Norcia (Australia) is operational since 2002 with a redundant maser
- A new station in 2005 was installed at Cebreros (Spain)
- It is planned a new maser for Kourou in the upcoming years

In 2005 two new GPS/GLONASS receivers were acquired. The installations are planned at:

- Tahiti. The Topcon receiver was installed in September 2006 at the same time of the Galileo experimental station.
- Malindi. The installation is planned for the end of 2006.

Several actions have been taken to improve the support of the IGS Real Time Network:

- The complete ESOC GNSS network is available in RT from the RTIGS relays.
- The installation of a receiver at Tahiti will close an important hole in the global network coverage.

A Septentrio EGNOS receiver was installed at ESOC in 2005 as part of an EGNOS monitoring network.

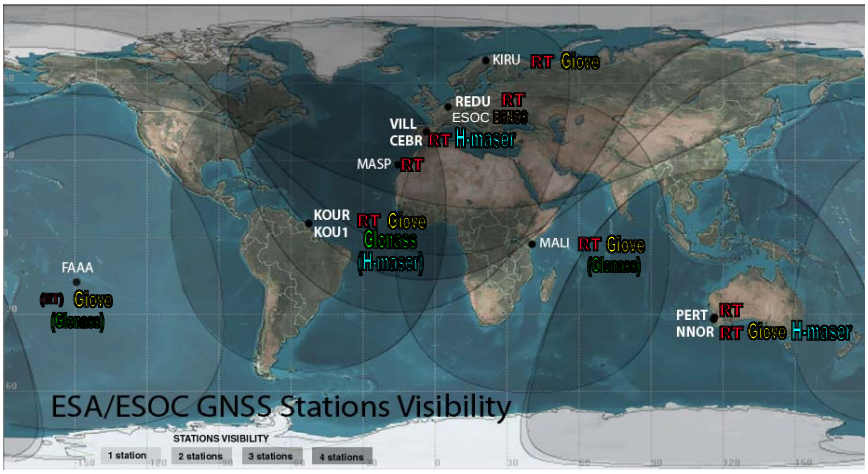

Figure 1 The ESOC GNSS Network (status June 2006)

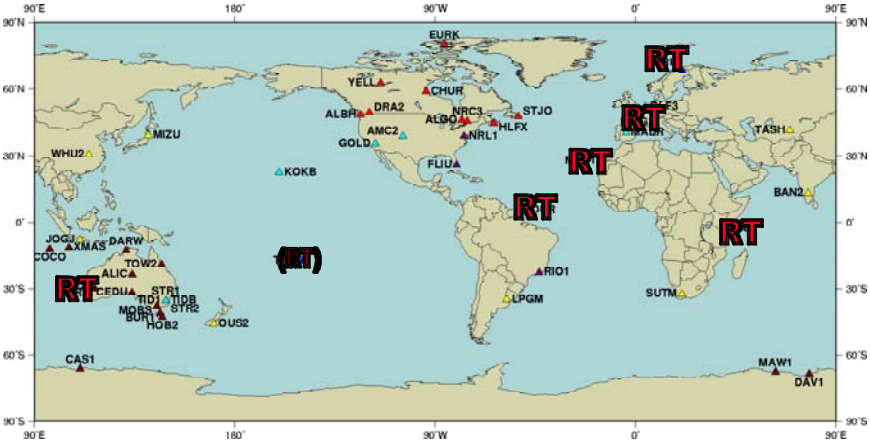

Figure 2 The ESOC real time stations in the IGS RTIGS network

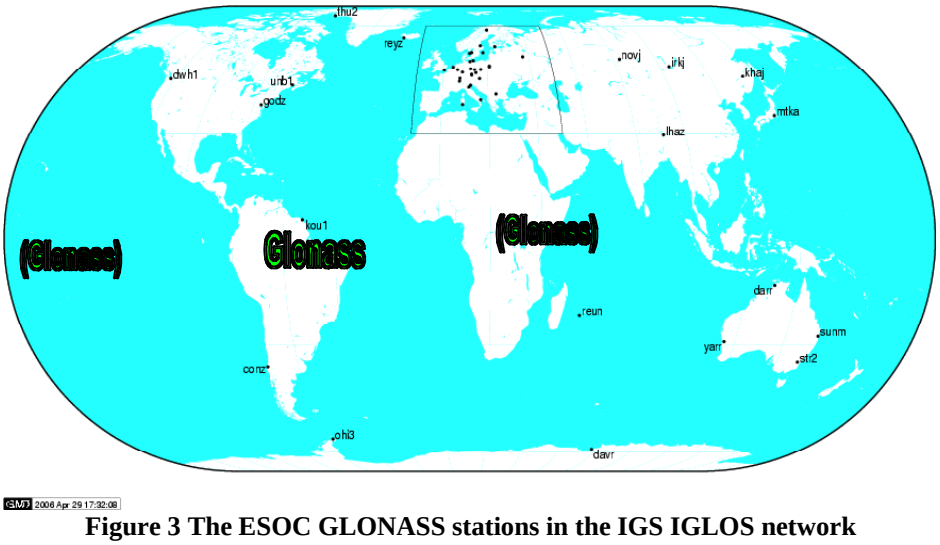

Figure 3 The ESOC GLONASS stations in the IGS IGLOS network

Network data flow

The current real time streams are resulting the migration from an ESOC development (own protocol and format) to the RTIGS protocol to improve compatibility and data sharing.

In order to support the NRT missions the full 15 min 1 Hz files have to be downloaded if some data is missing in the real time streams. This needs to be improved in the future to minimize bandwidth requirements.

The hourly and daily files for the IGS data centres are generated at ESOC from the 15 minutes 1 Hz data.

The native binary data of the receivers is not downloaded to ESOC due to bandwidth limitations.

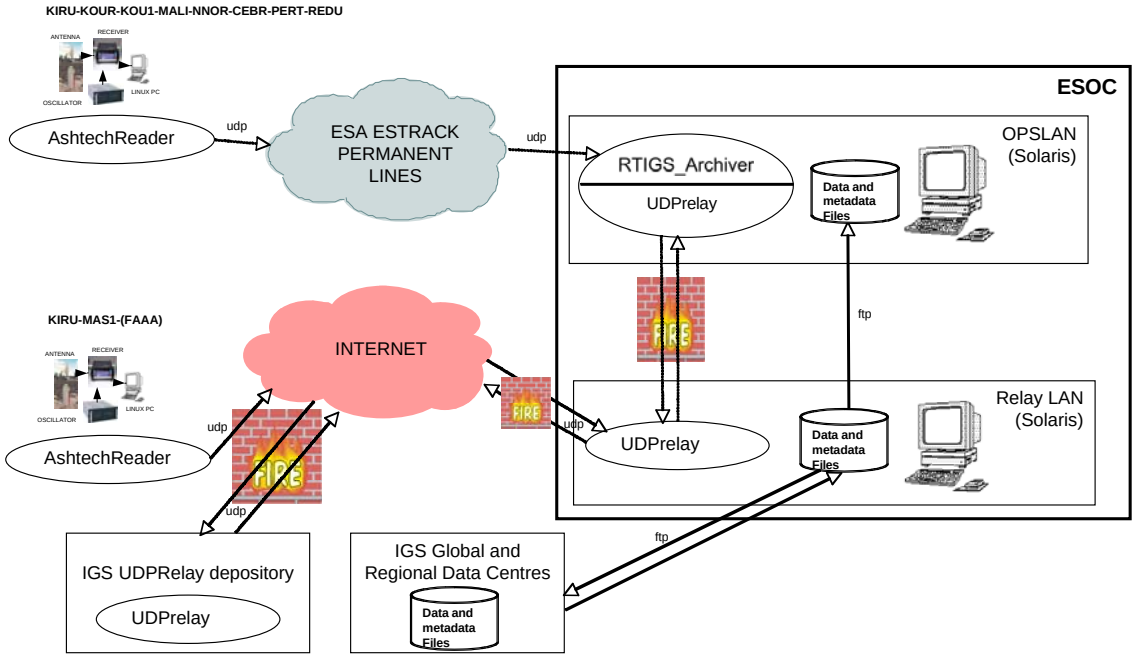

Figure 4 ESOC GNSS data flow

Impact of IGS recommendations

The IGS recommendations are followed for the ESOC network operation and any relevant modification. Some examples follow.

There is a clear recommendation to ”Avoid using radomes unless required operationally” but in Kiruna the coordinate series have presented discontinuities in the last years during

the snow covering and melting of the choke ring antenna. For the experimental Galileo Giove network the monument will be deeper and more centred in the plateau in order to overcome these problems.

Another recommendation is that ”Moving to another monument must be avoided”. In Kourou two monuments have been built in the past for the GPS (KOUR) and the GPS+GLONASS (KOU1) receivers. After checking with the IGS AC and network coordinators the procedure to follow for the use of the KOU1 monument for the experimental Galileo receiver is:

- Replace the KOUR antenna.
- Run the "modified" KOUR and the "original" KOU1 in parallel.
- Estimate the KOUR - KOU1 baseline before and after the equipment change
- Replace KOU1 with the Galileo equipment.

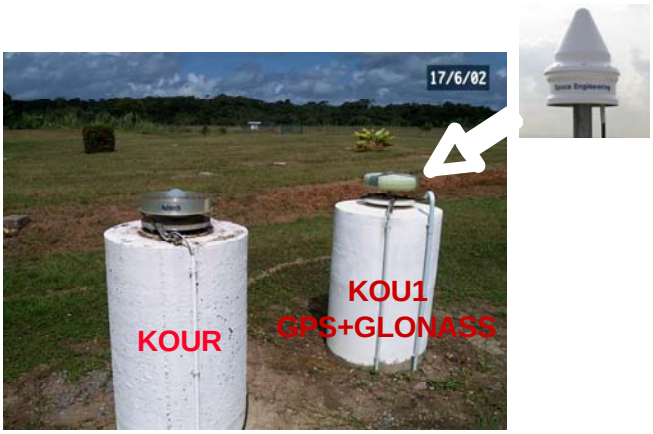

Figure 5 GNSS monuments at Kourou (status June 2006)

With the current proliferation of sites, IGS classifies them in:

- IGS Proposed Sites.
- IGS Provisional Sites.
- IGS Project Sites.
- IGS Product Sites.
- IGS Inoperational.

There is a continuous effort to add enhancements to the network to try to have “IGS product sites” and contribute to the IGS projects and working groups in a wider extent.

The Giove experimental network

The Giove experimental network is being deployed during 2006 to track the first Giove satellites, that are the first experimental Galileo satellites.

The Galileo System Test Bed V2 (GSTB-V2) is a prototype of Galileo and is a complete space and ground system. It will be made up of:

• 2 different satellites (GSTB-V2A and GSTB-V2B), each one with its own Ground Satellite Centre (GSC)
• a common Ground Mission Segment.

The GSTB-V2 is part of the risk mitigation program put in place by GAIN and ESA to secure the development of the Galileo programme, in particular with respect to the Galileo satellites and ground segment elements.

Figure 6 represents the Giove experimental network.

The systems deployed at the ESOC stations are Galileo Experimental Sensor Stations (GESS)

Thirteen GESS Stations will acquire continuously the GSTB-V2 signal-in-space and the GPS L1/L2 signals. Operation of the network is planned until September 2007, with extension possible for an additional year. See Figure 7.

According to Figure 8 each one of these GESS stations includes:
• An Experimental Galileo Receiver GETR with its antenna,
• An Industrial PC allowing data collection/storage and remote M&C capacity,
• A modem or a front-end providing the network access point in case of direct access,
• A Rubidium atomic clock for frequency reference.

Figure 9 represents a typical installation in the ESOC stations. A monument for the antenna is built in parallel to the IGS station providing a short baseline with the existing ITRF markers.

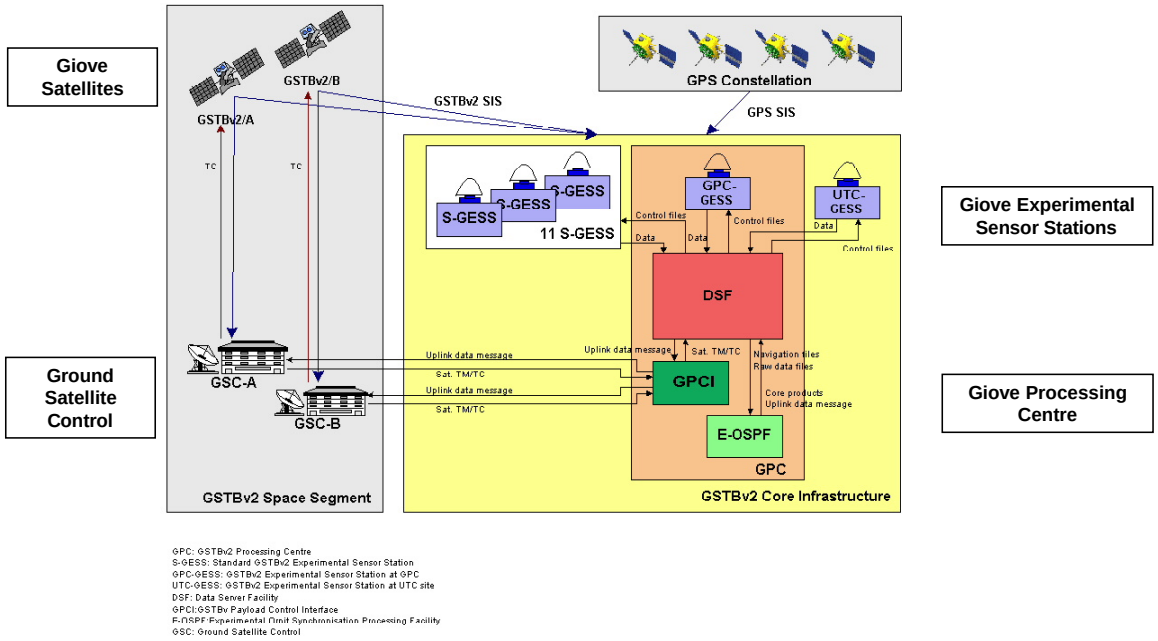

Figure 6 The Giove experimental network

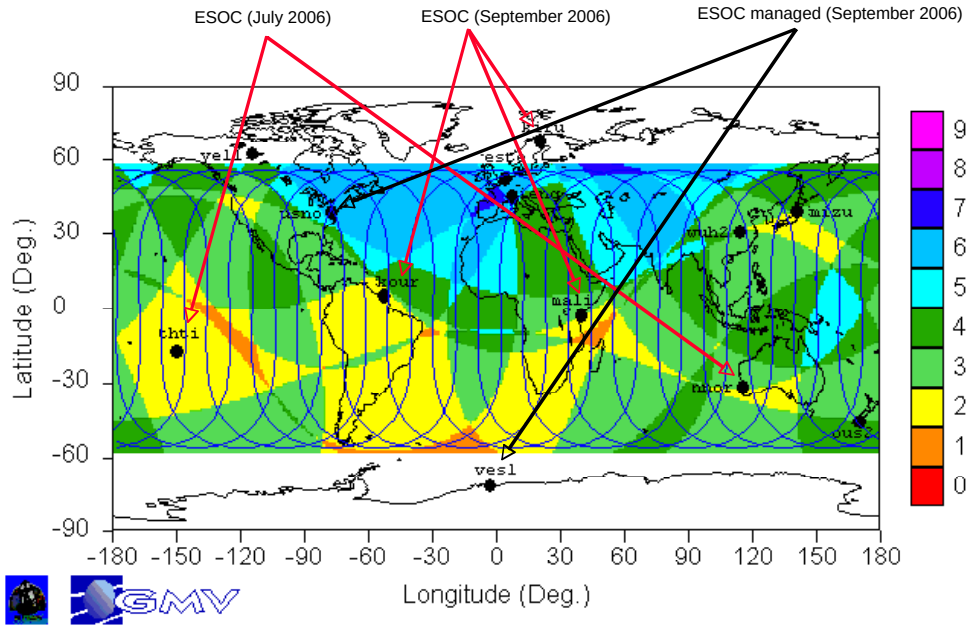

Figure 7 The ESOC Giove network deployment

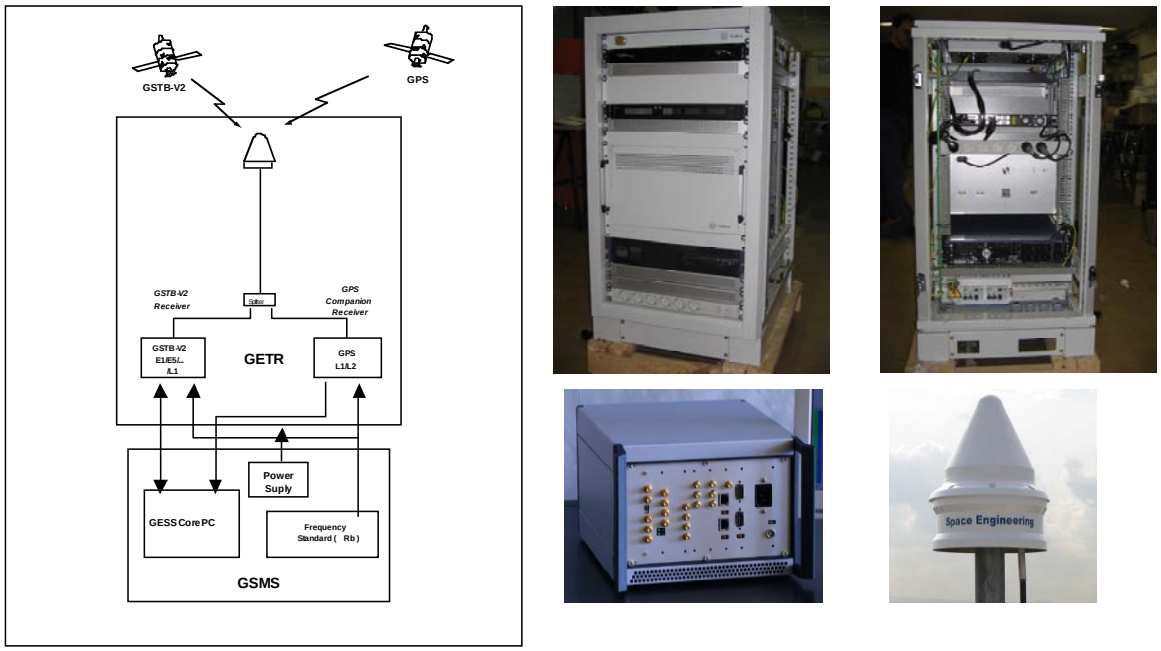

Figure 8 Giove stations equipment

Figure 9 Tahiti ESOC GNSS stations

Plans for the future

The main points in the plans for the future at ESOC are the following:

- Deployment of the Giove ground support network
- Deployment of GPS+GLONASS stations (Tahiti, Malindi)
- Deployment of RT stations (Tahiti)
- Kourou H-Maser
- Continued support to IGS
- Increase number of stations for all contributed products
- Involvement in IGS Real time WG pilot project