Networks and Stations

Global, Regional, and Local Networks

AUSLIG 1997 IGS Annual Report
Networks & Stations

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1 Australian Regional GPS Ground Station (ARGN)

The ARGN is a network of 15 GPS permanent ground stations extending from Antarctica to Cocos Island.

It consists of:

- Eleven AUSLIG sites
- One DSTO site, Salisbury South Australia
- ESOC site at Perth (IGS site)
- Tidbinbilla DSN/JPL site (IGS site)
- Yaragadee JPL (IGS site)

Of the eleven AUSLIG sites, five currently provide data to the IGS:

- Casey
- Davis
- Maquarie Island,
- Cocos Island
- Hobart

AUSLIG has also installed backup receivers at Tidbinbilla and Yaragadee sites. Data from all sites is processed by the AUSLIG Space Geodesy Analysis Centre as an IGS regional associate analysis centre.

2. GPS Data Center

The configuration of the GPS receivers and antennae at the sites are:

SITE	GPS Rx	GPS Vers.	ANTENNA	MONUMENT	DOME Hemi Sph
Casey	TurboRogue / Ashtech Z12	3.2.33.1 1F60	Dorne Margolin T	Concrete pedestal on rock	Yes
Cocos Island	TurboRogue	2.8.33.2	Dorne Margolin T	Concrete pillar	Yes
Davis	TurboRogue	3.2.33.1	Dorne	Steel rods in rock	Yes

SITE	GPS Rx	GPS Vers.	ANTENNA	MONUMENT	DOME Hemi Sph
	/ Ashtech Z12	1F60	Margolin T		
Hobart	TurboRogue	3.2.33.1	Dorne Margolin T	Concrete pillar	No
Macquarie Island	TurboRogue / Ashtech Z12	3.2.33.1 1F60	Dorne Margolin T	Concrete pillar	Yes

A new acrylic dome was placed on the Casey monument during December.

Improvements to the GPS data system at AUSLIG have resulted in complete redundancy in the system for conversion of receiver data files to RINEX. A RAID system is now in place on the AUSLIG ftp server.

3 Station Reports

3.1 CAS1

During 1997 the data logging system was partially upgraded, and an Ashtech Z12 GPS receiver was installed as backup to the TurboRogue and to support DGPS during the Antarctic summer. The receiver operates on the external rubidium oscillator.

3.2 DAV1

During 1997 the data logging system was completely upgraded, and an Ashtech Z12 GPS receiver was installed as backup to the TurboRogue and to support DGPS during the Antarctic summer. The receiver operates on the internal quartz oscillator.

3.3 MAC1

During 1997 the data logging system was completely upgraded, and an Ashtech Z12 GPS receiver was installed as backup to the TurboRogue and to support DGPS during the Antarctic summer. The receiver operates on the internal quartz oscillator.

3.4 HOB2

No changes were made to this site during 1997.

3.5 COC1

No changes were made to this site during 1997. The receiver operated on the internal quartz oscillator.

4. Plans for 1998

The network will be developed to meet full IGS specifications and all sites made available to IGS. A new IGS site will be established during 1998 colocated with SLR, Absolute gravity and DORIS at Mt. Stromlo near Canberra.

5. Contract Details

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The GPS Receiver Network of ESOC: Malindi, Maspalomas, Kourou, Kiruna, Perth and Villafranca

C.Garcia-Martinez (1), J.M. Dow,
T.Martin-Mur, J.Feltens (2), P.Bernedo (1).

(1) GMV at ESOC ; (2) mbp at ESOC.

1 Introduction

ESOC is currently involved in the establishment of a network of high precision geodetic receivers on ESA ground sites. So far, six installations have been carried out at the sites of Malindi, Maspalomas, Kourou, Kiruna, Perth and Villafranca. The establishment of this network is one of the objectives of the ESA GPS-TDAF (Tracking and Data Analysis Facility). Figure 1 shows the geographical distribution of the receivers.

ESOC GPS RECEIVERS

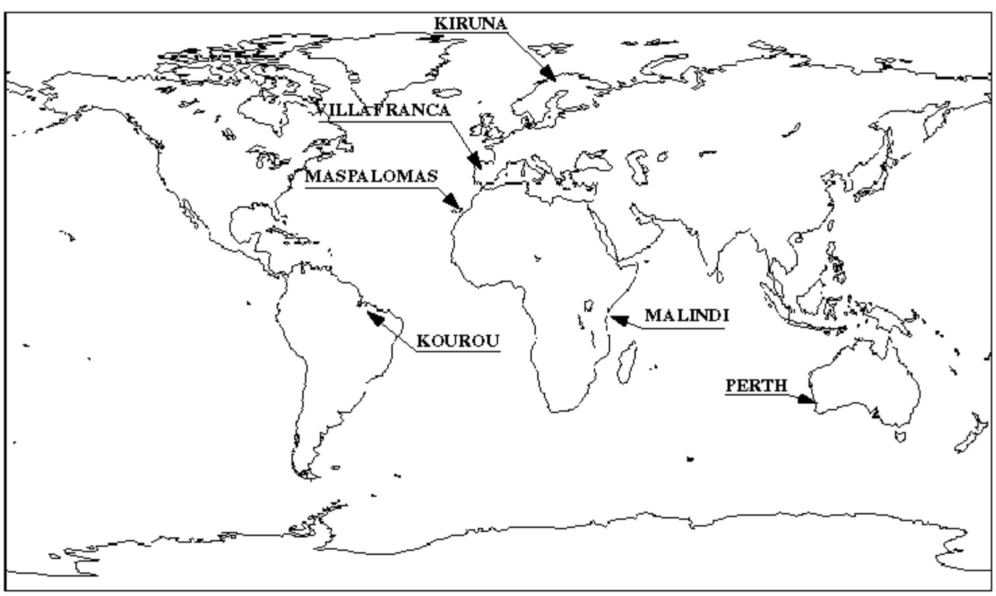

FIGURE 1

2 Location of the Receivers.

The ESOC receivers are being installed at the ESA ground stations. In this way they can take advantage of the facilities that the stations provide. They are integrated in racks in rooms with temperature and humidity control, connected to the frequency standards of the stations and to the permanent communication links between the stations and the control centre at ESOC. They provide, along with the rest of the GPS-TDAF, also several services. Examples are the monitoring of the behaviour of the timing system, the 1PPS output and the ionosphere monitoring over the station.

2.1 Malindi

The receiver is located at the base camp of the San Marco Scout launching site, which is a complex of facilities situated near the equator in Formosa bay near Malindi, Kenya. The station is on the coast about 115 km north of Mombasa.

2.2 Maspalomas

The GPS receiver is installed at the Maspalomas ground station, that is property of the spanish institute INTA. It is located in the southern part of the Gran Canaria Island, municipal district of San Bartolome de Tirajana, Spain. The site is approximately 1750 metres from the coast.

2.3 Kourou

The GPS receiver is installed at the ESA Kourou Diane station that is located about 27 km from the town of Kourou, in French Guyana.

2.4 Kiruna

The GPS receiver is installed in the ESA Kiruna ground station, that is at Salmijarvi, 38 km east of Kiruna in northern Sweden.

2.5 Perth

The receiver is located at the ESA Perth station, that is approximately 20km north of the city of Perth on the western coast of Australia. The station is situated on the Perth International Telecommunications Centre Complex, which is operated by Telstra Corporation Limited.

2.6 Villafranca

The receiver is situated in the Villafranca (VILSPA) ground station, located in Villafranca del Castillo, 30 km west of Madrid, Spain.

3 History and Evolution

The development of the network started at the beginning of 1992 when two MiniRogues SNR-8C, the most advanced receiver then, were ordered from AOA. After a period of testing in ESOC, the first installation was completed in the week before the start of the IGS campaign at Maspalomas. Data was available from 22/06/92. The antenna was mounted on a monument belonging to the Spanish IGN, that participated in several geodetic campaigns with the marker name MPA1. For IGS the selected marker name was MASP.

ESOC constructed another monument and on 11/04/94 installed a new GPS system with a TurboRogue SNR-8100. Both systems were operated in parallel for several weeks until the decommission of the old receiver. The marker name of the new monument is MAS1 and the IERS DOMES Number 31303M002 was assigned to it.

In the last months of 1995 the TurboRogue SNR-8100 experienced a degradation in the quality and quantity of the data that made necessary the replacement of the unit. Two new TurboRogues SNR 12 had been ordered and in April 96, shortly after the delivery and testing in ESOC, one of the new units was installed in Maspalomas.

The second of the MiniRogues was installed on late July 1992 at Kourou. Initially the data were downloaded directly from the receiver to ESOC using Telebit modems. Unfortunately the quality of the public telephone lines between Europe and French Guyana were very irregular. The data was obtained for a period of 10 days in August, and sporadically thereafter. Attempts made from Pasadena to dial up the Kourou modem were also unsuccessful. The low transfer rates and the irregular quality of the telephone lines made very problematic the completion of the file transfers using XMODEM. A new solution had to be implemented. It was based on the permanent links between the station and the control centre ESOC shared by several ESA projects. The regular operation of the receiver started on 18/10/92 when the connection to the new data link was completed. During the period when communications were not possible, a permanent concrete monument was constructed for the antenna there (see IGS mail No. 144). The antenna was moved by about -3.0,-1.1,1.1 m in longitude, latitude and height respectively from its previous position. The software of the MiniRogue was upgraded to version 7.8 on 06/10/94. The receiver was operated permanently without hardware problems for more than five years. In October 1997 the MiniRogue was replaced by an eight channels TurboRogue with the corresponding Dorne Margolin T antenna.

A set of five receivers model TurboRogue SNR-8100, was ordered at the end of 1992. After the testing period in ESOC, the first receiver was despatched to Kiruna and installed on July 1993. The receiver was placed in a building several metres away from the main building of the station. From here the distance to the monument is shorter. The monument is on top of a slope surrounded by trees. The antenna was replaced in May 95.

The second TurboRogue SNR8100 installation was performed on 13/08/93 at Perth. Unfortunately, a few days after the beginning of the operation, the receiver was damaged during a lightning storm on 03/09/93. A new receiver was immediately delivered. The earthling of the antenna has been improved to try to avoid the same problem happening again. The original receiver and antenna were repaired and reinstalled on 27/04/94.

Villafranca was set up on 12/11/94. At this site the cabling from the monument to the racks of the main building, where the receiver is integrated, is about 150 metres long. This is 50 m longer than the standard set-up of the receiver. This made necessary the installation of an additional line amplifier close to the antenna. With this modification the signal level has nominal values. At the beginning of 1998 this configuration presented several signal level problems and the receiver was moved to a portable station avoiding the necessity of the large cable.

The last installation has been Malindi. A MiniRogue SNR-8C was deployed at the station and started the data collection at the end of 1995. The data retrieval was initially via an analogue line that at the beginning of 1996 was replaced by a 64 Bit/s digital circuit. This facilities depend on other ESA projects and will be discontinued. A test with dial up modems using the recently improved PSTN at Malindi has been carried out successfully in May 96. The receiver is connected to a external 5 MHz quartz reference. In October 1997 a 12 channels TurboRogue replaced the old MiniRogue.

4 Monumentation

Figure 2 shows the monument specially developed for the GPS-TDAF. It is basically a reinforced concrete cylinder of 50 cm diameter that is situated over a foundation. On top of the cylinder there is an embedded horizontal metal plate. The marker is the centre of this plate, on the upper surface.

Three iron bolts are used to fix the antenna mounting in a horizontal position. The antenna is screwed to the mounting.

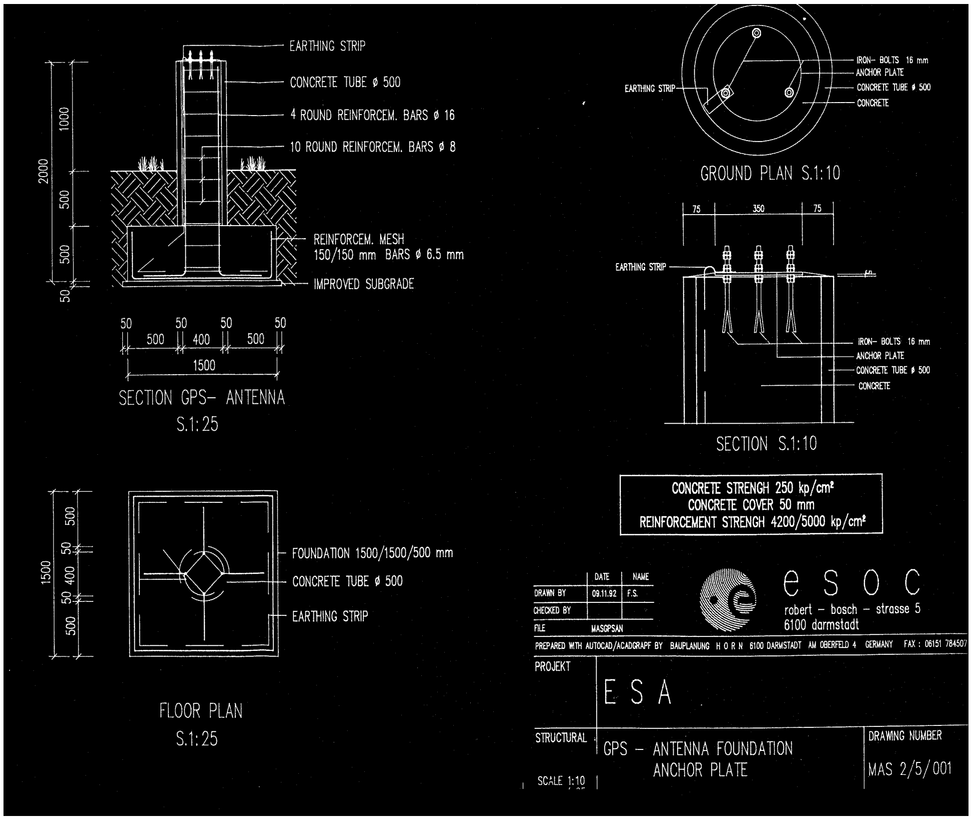

Figure 2

5 Equipment

The physical configuration of all the equipment involved in the remote stations part of the GPS TDAF is summarized in Figure 3.

The remote stations are continuously tracking the GPS satellites. The antenna is connected to the receiver normally with a standard 300 ft RG-214 coaxial cable. Only Villafranca has a cable 450 ft long, as remarked in the last section.

The timing system of the stations are used as 5 MHz reference frequency. They are cesiums manufactures by OSCILLOQUARTZ with long term drift controlled by timing GPS system.

All ESA stations are equipped with TurboRogues. In 1997 the last MiniRogues in Kourou and Malindi have been upgraded to TurboRogues.

One of the serial ports of the receivers is connected to a device that provides for communications and optionally for data storage. This device is a PC that runs a script of a communications package. Shortly after 00:00 UTC the PC downloads the data from the receiver with the XMODEM protocol, waits the remainder of the day for the call from the control centre ESOC and allows the remote control of the computer.

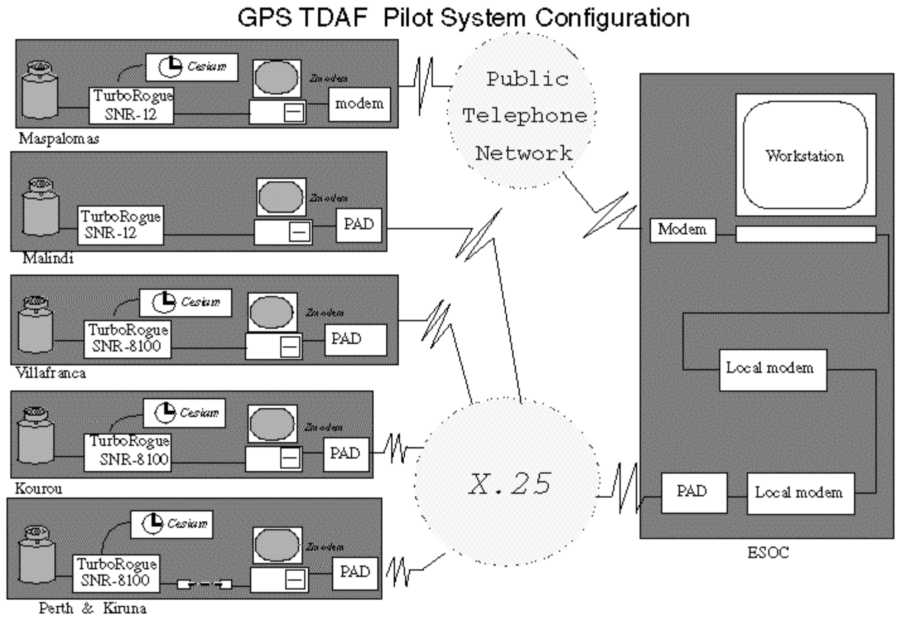

FIGURE 3

There are two main reason for the necessity of the intermediate device. First it buffers data. Several months can be stored on the disk. In addition it allows the data transfer to ESOC using a wide range of protocols. The XMODEM protocol, the only one supported by the receivers, is not suitable for the packet-switched networks that are sometimes involved in the communications with the control centre. It also provides flow control with the DCE (Data Communication Equipment).

The communication with the receiver is performed using the same line that is used for data downloading. The commands are sent to the PC that stores them and immediately changes the active comm port to the one connected to the receiver, sends them, waits the answer and stores it. The active port is swap again to the one connected to the communication device and the answer of the receiver is echoed. Several attempts have been done with a secondary line (PAD or modem) connected to the free port of the receiver for interaction with it in terminal mode, but the system has been shown to be more reliable without this secondary link.

For the communications with ESOC the permanent links between ESOC and the stations are used whenever possible. They are very reliable and do not introduce additional costs due to the small amounts of data involved.

At ESOC there is one workstation with two serial ports. One is attached to a Telebit modem and the other to an internal LAN of ESOC that gives access to the ESA ground station via X.25/PAD. This workstation retrieves, decompresses, reformats, validates, archives, recompresses and distributes every day the data automatically. The nominal time when all the processes are finished is 02:00 UTC.

The data are available to the IGS community in RINEX format via the official data centres.

At Malindi the receiver is a TurboRogue SNR 12 RM. The antenna is Dorne Margolin T with a height of 0.1347 m and is located at the centre of the station. Data have been retrieved by means of a permanent digital circuit and since the end of 1996 we are making use of the very improved PSTN at Malindi station for data downloading using OCTOCOM dial-up modems.

In Maspalomas the receiver is a TurboRogue SNR 12 RM. The antenna, Dorne Margolin T, is mounted over a monument located several metres east of the Main Equipment Room. The antenna height is 0.033 m. The data retrieval is performed with a Telebit T2500 modem. A PAD (Packet Assembler-Disassembler) that runs over a 64 Bit/s line has been used in the past.

Kourou is equipped with a TurboRogue SNR-8100. The antenna is Dorne Margolin T with a height of 0.045 m and is located about 25 m from the MCR (Main Control Room) building.

Kiruna has a TurboRogue SNR-8100 and a Dorne Margolin T antenna with a height of 0.062 m. The communications are performed using a PAD that runs over a permanent circuit between ESOC and Kiruna Station.

The TurboRogue of Perth is connected to a Dorne Margolin T antenna which has a height of 0.0595 m. The communications are carried out by means of a PAD that is situated in a different building of the station. To overcome this problem, two local modems had to be used. They provide for communications between PC and PAD.

Villafranca has also a TurboRogue with a Dorne Margolin T antenna. The antenna height is in this case 0.0437 m.

6 Plans for the future

There are currently two ESA sites that offer possibilities for future installations. They are Odenwald (Germany) and Redu (Belgium). They are really more interesting for other projects than for IGS. The baseline of the plans for the future, concerning IGS, is more than new installations, the improvements of the current ones with the last hardware and software available and provide for an even more robust communications tending to the real time data availability at ESOC.

We are working on a Real Time Infrastructure project that will replace the software that currently is running in the remote stations PC's to a more versatile one that will provide for continuous data downloading to the control centre at ESOC and will enhance the data analysis capabilities.

In 1998 communications between ESOC and the Ground Stations will be reviewed and the GPS TDAF will have to look for new connectivity solutions for several stations.

7 References

- GPS TDAF Stations Configuration Manual. Version 1.1, December 1995, ESOC.

- The GPS receiver network of ESOC: Maspalomas, Kourou, Kiruna, Perth and Villafranca. C.Garcia-Martinez, J.M. Dow, T.Martin-Mur, J.Feltens, M.A. Bayona-Perez. 1994 IGS Annual Report.

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GPS Global Network Operations at JPL and the UNAVCO Facility

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1 Transfer of Station Engineering and Maintenance Activities to UNAVCO

A proposal to collaboratively operate the NASA GPS Global Network (GGN) was developed jointly by JPL and the UNAVCO Facility and was submitted to NASA in April 1997. Arrangements were formalized in June, upon notification by NASA that the combined effort would be funded, and part of the responsibility for operating the GGN was transferred from JPL to the UNAVCO Facility during the last half of the year. Under this new arrangement, JPL is providing overall management of the GGN effort and is providing most of the data management system development and operations. The UNAVCO Facility is handling most of the station-level engineering and maintenance, including performing the new station installations and establishing data flow; enhancing the capabilities of existing GPS stations and data return; sharing the network monitoring responsibilities; supporting station-level troubleshooting and repairs; maintaining station configuration information, including the IGS logs; retrieving data from some of the more problematic stations; and supporting improvements to data retrieval, verification, management and reporting systems.

2 GPS Station Installations and Maintenance

Working in close cooperation with various international partners, JPL and the UNAVCO Facility have supported the installation of eight new GPS tracking stations in 1997 on behalf of NASA, including two new stations in Russia, three in Kyrgyzstan, one in Colombia, one in South Africa, and one in Turkey. Five of these already regularly provide data to the IGS, as will the others once they are capable of reliably returning data. Significant planning and preparations were also accomplished for several new stations to be installed during 1998 at locations including Brazil, China, Cote D'Ivoire, Morocco, and the Philippines.

Of the approximately 60 stations comprising the NASA Global Network (excluding the dense array stations in California and other locations), fifteen required the replacement of faulty receivers or antennas during 1997; four required the replacement of on-site computers; two required replacement of faulty telecommunications equipment;

two required establishment of new telecommunications services; and four required engineering staff visits for on-site troubleshooting, repair or re-configuration.

3 Improvements to Data Retrieval, Verification and Management Systems

Improvements made to data retrieval, verification and management systems have focused on enhancing overall data return and timelines of data deliveries to users, and on improving the quality and reliability of GPS data and associated descriptive information.

JPL’s GNRT (Generalized Near-Real Time) software, which provides rapid-turnaround, data-driven, queued processing of any type of data, was tested in a configuration which produces daily RINEX files for NASA’s Global Network stations. This set of Perl scripts is able to complete the RINEX production within minutes of receipt of raw GPS data and it is envisioned that this scheme may provide the IGS with a "Rapid Service" RINEX function in the future.

The JPL GNEX software, a PC/Linux based software package, which performs unattended data retrievals at remote GPS stations, was improved to include a prototype module for controlling Trimble receivers, based on the UNAVCO LAPDOGS (Local Automated Process for Downloading of Global Sites) software tool, which is currently being used at a number of installations. Capability was also added to support a broader set of commonly available modem types.

The UNAVCO software tool TEQC (Translate/Edit/Quality Check) was modified to include translation capability for ConanBinary and TurboBinary data types. For TurboBinary, this includes translation capability for normal-rate data, high-rate data (up to 50 Hz sampling rate), and the mixed "30-1" format contained LC observables. The raw data can contain any mixture of these types, and TEQC allows the user to easily extract the desired portion, e.g. extraction of just normal-rate (30 second sampling) from the "30-1" format. This code was also adapted for TurboBinary from the Allen Osborne Associates Benchmark receiver, to store the C/A-derived phase value for the RINEX L1 observable. The ConanBinary translator currently handles ConanBinary from the TurboRogue/TurboStar series and Benchmark receivers, though not for the original Rogue receiver. The TEQC software is used by several IGS participants, including UNAVCO, JPL and the CDDIS (Crustal Dynamics Data Information System) Global Data Center, for GPS data file conversion and validation/verification. UNIX and DOS versions are available on-line at the UNAVCO Facility web site (http://www.unavco.ucar.edu/software/).

Scripts to automatically compare descriptive information from the Central Bureau Information System (CBIS) and the CDDIS station log summary files and RINEX files were developed and are run daily to identify any discrepancies, with results posted at the CBIS. This information has been used extensively by JPL and the UNAVCO Facility to verify the GGN station log and RINEX header metadata and correct inconsistencies.

4 Plans for 1998

Up to seven new permanently operating GPS stations will be installed at global locations in 1998 in support of NASA activities and all will provide data to the IGS. Funding has been secured to improve data flow at several existing GPS stations by upgrading some with new PC/LINUX download systems running GNEX and improving Internet connectivity at another subset. At least four new automated meteorological data recording packages, funded by the US National Science Foundation, will be placed at GGN stations during 1998, with possibilities for additional units becoming available from other sources later in the year.

GNEX software functionality will be expanded to support Ashtech receivers and a new module to automatically establish dial-up PPP (Point-to-Point Protocol) connections will be added. Other modifications are also planned, including integrating data from automated meteorological recording instruments into the data flow, and rewriting sections of the code to improve operability and maintainability of the software.

The lightweight GNRT system for producing RINEX products is self-contained and portable among UNIX systems, making it appropriate for use as a backup to the JPL data retrieval and management operations in the event of a large-scale failure. The GNRT system will be installed at the UNAVCO Facility during 1998, and operational procedures will be developed and regularly exercised to assure adequate and maintainable back-up coverage. The Pacific Geosciences Center also hosts a minimal additional back-up system and a GNRT installation is planned there, as well.

A 24-station near-real time subnetwork of the GGN, which has provided hourly data since late 1996, is the springboard for the development of a subnetwork of high-rate, low-latency sites for ground support to CHAMP, GRACE, and other Low-Earth Orbiters (LEOs) being pursued cooperatively by several agencies. Utilizing existing GPS tracking stations is envisioned, with communications and receiver systems upgrades where appropriate. Highly capable, yet economical LINUX computers at the stations would host the "Smart Sites" software, currently being developed based on the GNEX package, allowing on-the-fly data verification/validation, active notification of error conditions, and other sophisticated new modes of reliable, automated site operations. GNRT processing would provide the required rapid turnaround of the LEO ground GPS network data to users. Detailed GPS ground network segment requirements are currently emerging and NASA and other funding is being pursued to support the LEO efforts.

The value of hourly data to applications such as rapid orbit prediction and atmospheric monitoring is clear, and JPL/UNAVCO will strive to increase the coverage of the hourly subnetwork and make these products broadly available. In addition to the GGN sites with sufficient communications capability for hourly data retrievals, several other partners such as SK, BKG, GFZ, and OSO, also make hourly data available from some stations and it is hoped that the IGS will endorse and promote the acceptance of hourly data in the future.

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