EUREF and Real Time Products

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Abstract

With the increased capacity of the Internet, applications that transfer continuous data streams by IP-packages, such as Internet Radio, have become well-established services. Compared to these applications, the bandwidth required for the transfer of real-time GPS data is relatively small. Thus, at least from a technical point of view, it seems recommendable for EUREF to consider the use of the open Internet for real-time collection and exchange of GPS data, as well as for broadcasting derived products for which a massive public interest is to be expected. Possible fields of application could be the transfer of raw or RINEX data from reference stations to central computer facilities, or the continentally distribution of RTCM corrections over the Internet for navigation purposes. These could be homogeneously referred to ETRS89 and monitored by EUREF.

This paper focuses on technical aspects of possible real time product implementations through EUREF and the installation of a trial service providing RTCM corrections. The trial service, see http://igs.ifag.de/gref_realtime.htm, is based on a reference station located in Frankfurt am Main. The paper furthermore intends to initiate and stimulate a discussion on the pros and cons of a EUREF responsibility regarding a European-wide DGPS reference service via the Internet.

1. EUREF and Product-Lifetime

The major products of EUREF are coordinates. As originally derived from single GPS observation campaigns beginning 1989, the lifetime of these products was actually intended not to be connected to a limit. Later on, these campaigns where repeated to estimate station velocities. As a consequence, the lifetime of coordinates was reduced to several years. With the advent of the EUREF Permanent Network (EPN), the product lifetime decreased again, now to the order of a single week, following the EUREF weekly combined coordinate solutions. In July 2001, a new product, the hourly estimated troposphere parameters, became an official part of EUREF activities. This short review of a decade of EUREF work points out that the lifetime of results is continuously dropping down towards real-time, mainly taking advantage from today's communication capabilities via Internet.

2. GPS and Real-Time

A variety of modern geodetic GPS applications needs data in real-time. Among the most ambitious is the orbit determination for LEO-satellites, which would like to use a continuous stream of observations from a number of reference stations. Further obvious examples with real-time needs are DGPS and RKT navigation and positioning, where RTCM-corrections with a maximum lifetime of a few seconds have to be made available. The type of information to be provided in real-time varies from raw to RINEX-data, from pseudo range and range-rate corrections to carrier phase data. Real-time data streams might be used to compile batches of GPS observations covering short periods of 60 or 30 minutes to suspend today's hourly reference station uploads.

Fundamentally, EUREF is confronted with the question of whether or not and perhaps how to support the generation and maintenance of real-time GPS products. This question draws away from the explicit responsibilities for post-processed coordinates towards other needs of the Navigation and GIS communities and their DPGS or RTK services. This policy aspect concerning EUREF's further activities is looking for an answer.

3. Real-Time GPS and Internet

The Internet is one of today's promising media for GPS information transport (see *Hada et.al. 1999* and *Kawakita et.al. 2000*). As an open network, it can easily be used by anyone. It offers bi-directional communication links, which is a necessity i.e. for networked DGPS or RTK reference stations if the service-concept of Virtual Reference Stations (VRS) is applied. The bandwidth, which needs to be in the order of 50 bytes per second for DGPS applications, is available nowadays. To give a comparative example: Downloading the EUREF homepage is equivalent to receiving 5 minutes of real-time DGPS corrections. Even the average transmission volume of 500 bytes per second for RTK applications can be handled over the Internet. Occurring latencies are usually in the order of a few hundred milliseconds in western European countries. They might exceptionally reach up to one or two seconds, which is harmless at least for DPGS. The wired character, coverage and performance of the Internet thus seem sufficient for a variety of new geodetic services (see *JPL, Orbiter and Radio Metric Systems Group 2001*).

Of course, there is a lack of availability with the Internet that has to be somehow handled. We all know times, when a specific link is not available. This can be overcome by introducing a certain level of redundancy. A GPS reference network, communicating over the Internet, might include more stations than necessary, thereby gaining the capability to live with a certain level of failures.

Furthermore, disseminating GPS real-time information via Internet is a comfortable solution from a service provider's point of view. Operating an Internet daemon broadcasting in multicast-mode is all what's necessary to obtain an even global coverage of services.

4. Internet and Cellular Phone Networks

For DPGS and RTK applications using the Internet, the communication line between the reference network und a mobile user consists of two consecutive elements. The major (wired) communication distance is covered by the Internet while the residual shorter distance can be covered by cellular phones (see Figure 1). Involving cellular phone techniques at the user end solves the mobile communication problem quite advantageously. The outstanding coverage, performance and bandwidth of cellular networks are almost beyond comparison to other approaches. At least from a national or European strategic point of view, other local broadcasting techniques appear less sufficient, satisfying, or promising. The disadvantage of costs might become less worrying as prices are hopefully dropping further.

GSM, today's cellular phone standard, will soon be extended in Europe by GPRS and UMTS. This will open additional fields of applications. Linking navigation and communication techniques (GPS & Internet plus Cellular Phone) is a prerequisite for location-based services over the Internet. Actually, DPGS and RTK are nothing else but location-based services.

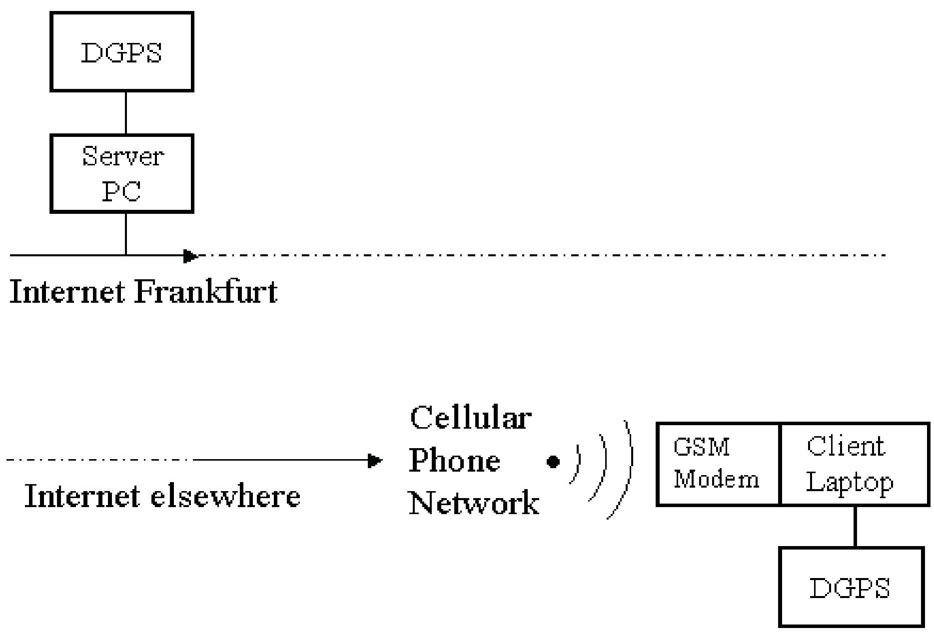

Figure 1: Principle of DPGS/RTK over the Internet

5. Hard- and Software for DGPS/RTK over the Internet

In order to set up a DGPS service on the Internet, at least a GPS reference receiver generating RTCM corrections (or a GPS radio receiving broadcasted RTCM corrections) must be available. The reference receiver/radio needs a serial link to a PC on the Internet hosting RTCM server software. The mobile user of such a DGPS service needs client software on a PC connected to the Internet, i.e. through a GSM modem. The client PC feeds the serial input of a GPS rover. Server as well as client software is available from the Internet. Basically the server grabs the serial byte stream from my DGPS reference and sends it off over a TCP connection. The client does the same thing but in reverse (see *Rupprecht 1999-2001*). Please note that information on free or commercial programs may be obtained from the author. Server software is known for Linux and WinNT systems, client software for Linux and Windows systems including WinCE (see i.e. *Taylor 1999-2000* and *TAL Technologies 2001*).

6. DGPS/RTK Trial Service at "euref-ip.ifag.de", Call for Participation

The BKG has established a Trial Service in Frankfurt available at "euref-ip.ifag.de". Port 2101 provides RTCM-2.0 (DPGS) corrections whereas port 2103 provides RTCM-2.2 (RTK) corrections. If a firewall between on the users internal network and the Internet blocks connections to these ports, the use of a public Internet Service Provider is recommended.

In order to investigate and study the possibilities for disseminating RTCM corrections over the Internet, it is intended to implement additional DGPS sever at a small number of EUREF LAC's. The service, which is looking for densification, may be called "euref-ip", where "ip" means Internet Protocol. A few selected EPN reference stations, separated by about 500 km, could provide real-time data to co-located DGPS servers on the Internet. Agencies interested in real-time activities are kindly requested to participate in the current tests and developments.

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