The OSi National Network RTK Solution

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Key words: GPS, Network RTK Solution, GSM

SUMMARY

This paper describes Ordnance Survey Ireland's implementation of a realtime Network RTK (Real Time Kinematic) GPS solution in Ireland. This implementation is based on the upgrading of an existing active GPS network in Ireland that comprised Ordnance Survey Ireland, Ordnance Survey of Northern Ireland, and Commissioners of Irish Lights GPS stations.

The realtime Network RTK solution is based on Leica Geosystems technology and allows up to 180 simultaneous users to access the positioning service by means of GSM mobile phone communications. The paper goes on to describe the various solution components such as hardware, processing software, communications, security, and geodetic reference framework.

Before the paper concludes by outlining the future developments planned for the national realtime positioning service, it describes the important lessons learnt regarding suitable site location and the fact that network stability comes from stable communications

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1. INTRODUCTION

Ordnance Survey Ireland (OSi), the Irish national mapping agency, has a tradition of being at the leading edge in the use of new technology. Over the past decade OSi has been one of the world's largest civilian users of digital photogrammetry and continues to invest in new technology when it is proven to be cost effective in improving map production flowline efficiencies. This paper outlines OSi's recent implementation of a new GPS 'Network Real Time Kinematic (RTK)' solution for Ireland which has been developed in conjunction with Leica Geosystems.

2. OSi NETWORK RTK SERVICE

The OSi national GPS Network, which enables surveyors to determine realtime positions around the country using a geodetic GPS RTK receiver and GSM mobile phone communications, has been implemented as an upgrade to an existing active GPS network in Ireland. That existing network comprised sixteen active GPS stations, of which ten belonged to OSi, three to the Ordnance Survey of Northern Ireland, and three to the Commissioners for Irish Lights. This sixteen station network was developed primarily to provide an hourly GPS RINEX data download service via the Internet www.osi.ie. A secondary service, involving a subset of four of the OSi active GPS stations around the Dublin area, provides a realtime positioning service for Dublin and its environs.

The new national Network RTK service is an upgrade of the existing network in software, hardware, and communications infrastructure to provide a realtime positioning service around the country. This new service is currently in the final stages of beta testing and is due to be launched as a 'pay-per-use' realtime positioning service by the summer of 2004.

2.1 Overview

The new Network RTK solution currently comprises twelve OSi active GPS reference stations as shown in Figure 1 on the following page. As this realtime GPS positioning service is based on GSM communications, the current reference station locations have been chosen in order to provide sufficient coverage in areas around the country where there is also good GSM coverage. OSi made the decision not to establish addition GPS reference stations on the West coast of Ireland initially, but to wait until a time when GSM coverage had also improved in this area, thus enabling the realtime positioning service to be accessed.

This new national realtime positioning service is based on Leica Geosystems hardware and software, the elements of which will be described in section 3 of this paper.

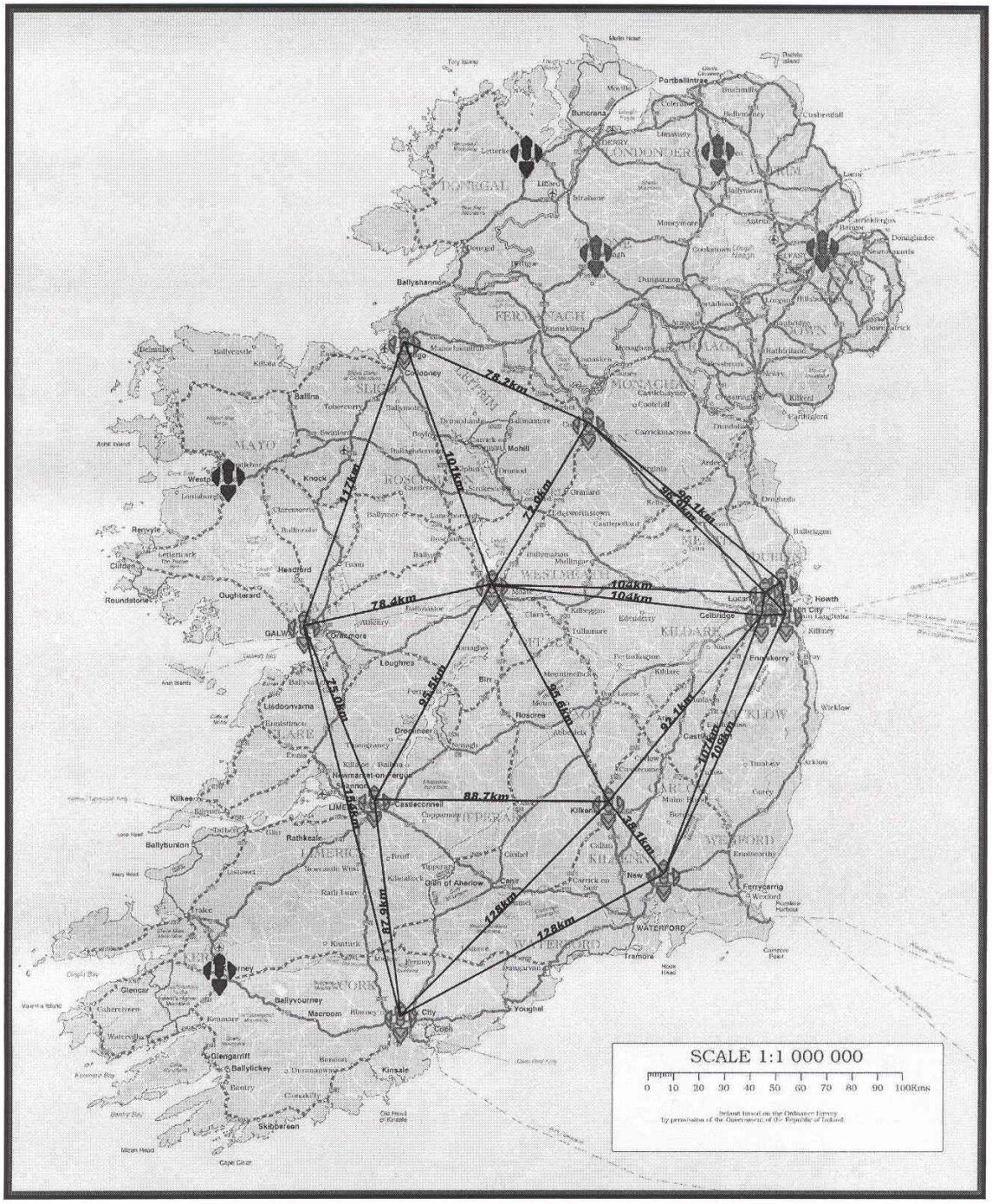

Figure 1: The twelve active stations and their baselines in the national Network RTK network

The national realtime positioning service is currently only available to internal OSi users as it is in the final stages of beta testing. OSi map revision field staff have been using the system for a number of months and have been involved in a programme of continuous monitoring and testing. When positions have been compared to known ETRF89 (European Terrestrial Reference Frame 1989) control points around Ireland, agreement has been consistently within the four centimetre range.

The network performance and stability has reached a level of confidence for OSi to finish its beta testing and initiate the roll out of the service to the survey community as a 'pay-per-use' service. OSi is currently finalizing both the pricing model and the charging mechanisms with the national communications service provider. The realtime positioning service is scheduled to be launched before the summer of 2004. The service will be accessed by users by means of a GSM communications link with their geodetic GPS receiver and standard RTK surveying application. Access will be via a single premium rate telephone number, with the system allowing up to 180 simultaneous users to avail of the service at any one time. If demand requires, this maximum number of simultaneous users can be expanded by adding additional communications hardware.

2.2 Existing RINEX service

In parallel with the new realtime GPS positioning service, the existing GPS hourly RINEX service will continue to be provided over the internet www.osi.ie for those users wishing to avail of positioning by means of GPS post-processing. This RINEX service for Ireland currently consists of downloadable hourly five-second RINEX files from an archive period of three months for the twelve OSi active reference stations and for the three Ordnance Survey of Northern Ireland active reference stations.

3. SOLUTION COMPONENTS

The OSi national GPS Network RTK solution is based on Leica Geosystems technology. This section will describe the separate solution components of hardware, processing software, communications, security and geodetic reference framework. Figure 2 on the following page shows the various solution software and hardware components and solution connectivity.

3.1 Hardware

Each of the twelve OSi active GPS reference stations used in the solution consists of the same hardware configuration:

- Leica Geosystems Choke ring antenna with radome antenna (as seen in figure 3)
- Wall mounted security box containing
  - Leica Geosystems CR500 dual frequency geodetic receiver
  - UPS x2 (Uninterrupted Power Supply) and Fan
  - PSTN and GSM communications links
- Lightning arrestor

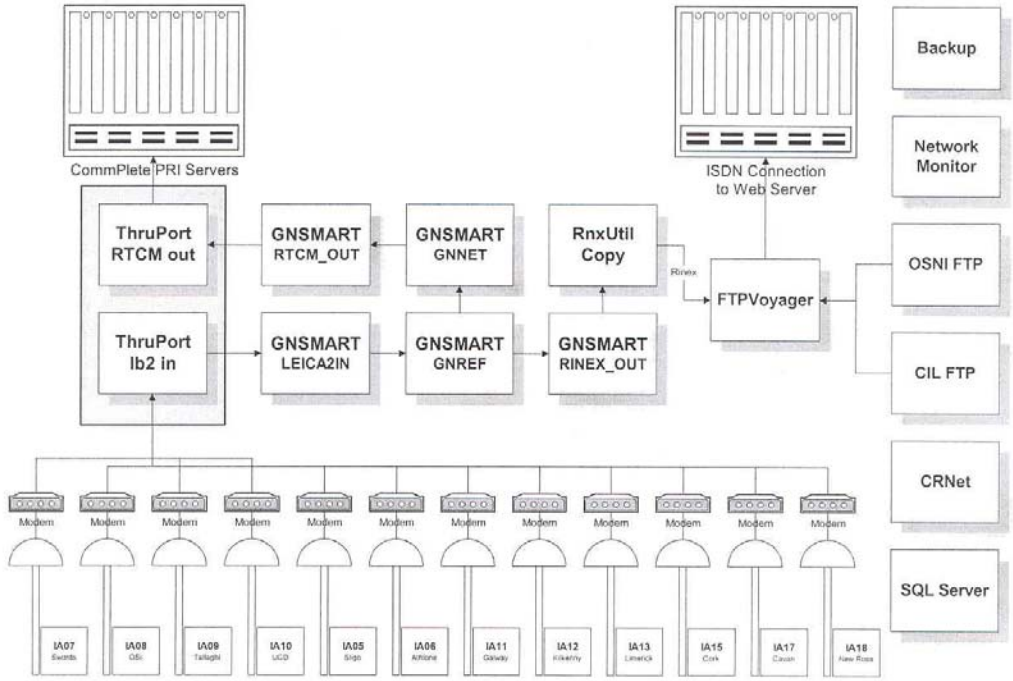

Figure 2: Software and hardware components and connectivity

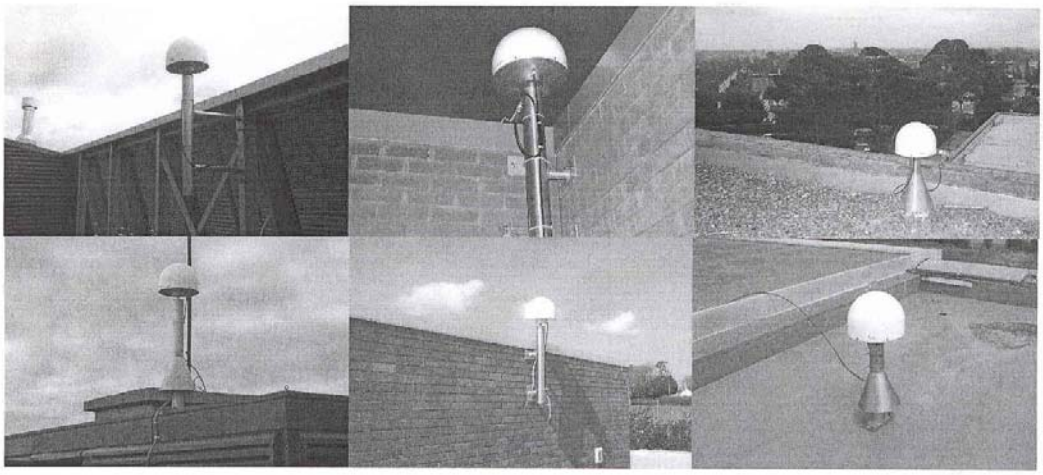

Figure 3: Some of the OSi active GPS reference sites

3.2 Processing Software

The software component of the network solution is primarily the Leica Geosystems GNSMART / GEO++ package, supported by the Leica Geosystems CRNet network processing software and a communications software package named ThruPort.

3.2.1 GNSMART

GNSMART is a suite of modules that are called via a script (batch file). Each module is run from the command line and each module has its own unique parameters. The script uses a number of the GNSMART modules of which four are listed below:

- *LEICA2IN* – This module handles the connection to a Leica System 500 receiver and is also responsible for creating the RINEX files for post-processing.

- *RTCM_OUT* – This module handles the incoming connections from Rover Units using FKP RTCM. This feed provides resolved RTCM (18/19) feed as transmitted from a PRS (Pseudo Reference Station). The module is configured as a TCP/IP server, meaning that it can handle numerous clients. Hence more than one Rover Unit can receive RTCM feeds from a particular RTCM_OUT module.

- *GNREF* – This is the mathematical core of GNSMART. This takes the incoming data from modules such as LEICA2IN and processes it, making the results available for other modules such as RTCM_OUT and GNNET.

- *GNNET* – This module takes data provided from GNREF to create area correction parameters (FKP- Flächenkorrekturparameter is German for area correction parameters). These corrections are transmitted to Rover Stations as an FKP RTCM feed. GNNET also provides feedback that is very useful for determining the state of the system, querying satellite data and checking the status of the receiver sites.

3.2.2 CRNet

As GNSMART is a realtime GPS processing software application, CRNet is used only as a backup system to back fill Rinex data in situations where GNSMART was not running or creating Rinex files in realtime. CRNet can be used to download Rinex files from all the sites simultaneously or the user can select which sites to download from.

3.3 Communications

3.3.1 ThruPort

Thruport is a self-contained system that handles communication between GNSMART, the GPS receivers and remote Rover Stations. This proprietary software was written by Survey Instrument Services Limited, the Leica Geosystems agent in Ireland. Thruport can handle a

variety of communication layers and protocols including serial, TCP/IP, TAPI and Telnet. The main features are:

- *Connect to multiple RTK Reference Stations* – ThruPort can connect to multiple RTK Reference Stations simultaneously. The only limit is the number of connections that the computer has access to.

- *Transmit RTK corrections to multiple Rover Stations* – On receipt of an RTK correction, ThruPort polls all incoming (Rover) calls and transfers the RTK correction to the appropriate channels.

- *Monitor usage and other reports* – ThruPort is also used to monitor usage, connection times to the Rover and Reference Stations, least popular/most popular times and stations etc.

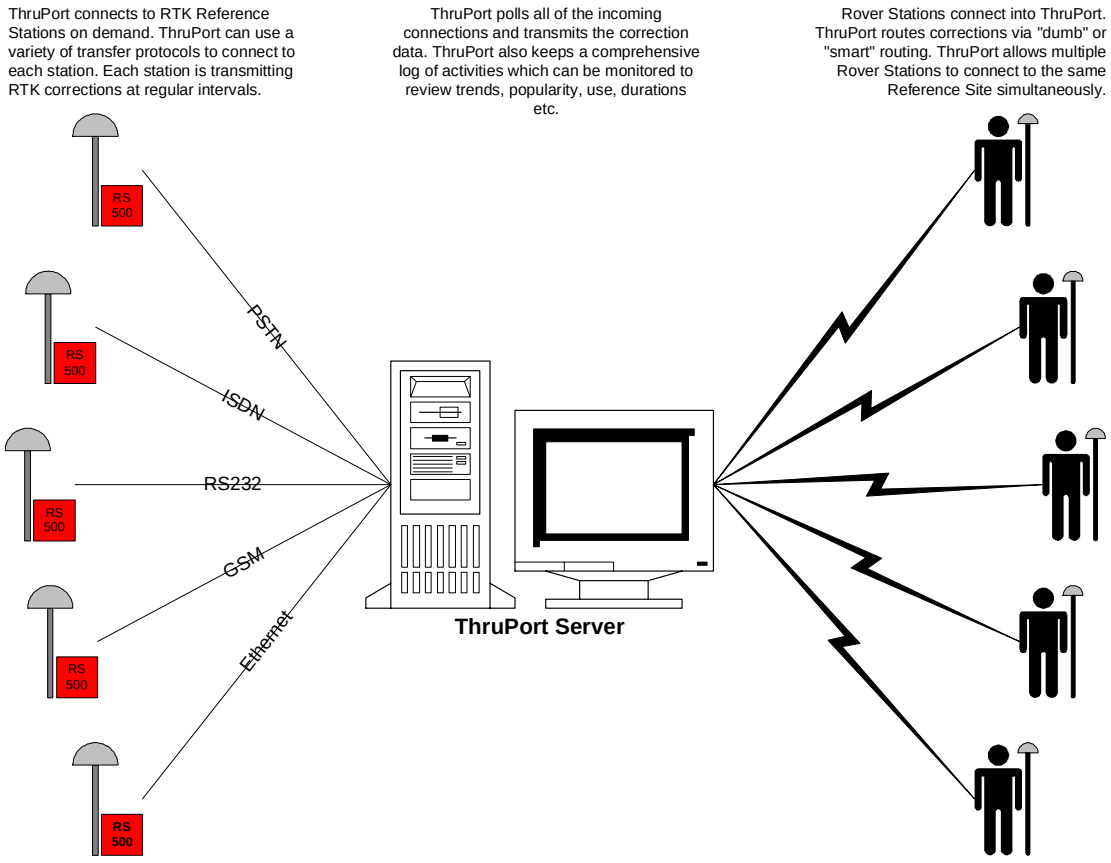

Figure 4: The ThruPort server

3.3.2 GSM maintenance link

Survey Instrument Services Limited, which is responsible under contract for the maintenance of the GPS equipment and software, has recently implemented an additional communications link between the GPS server located in OSi Headquarters in Dublin and each of the twelve active GPS reference stations around the country. This involved installing GSM dial in capability in each of the twelve Leica Geosystems CR500 receivers in addition to the existing PSDN dial in capability. In the event that any one of twelve PSDN telephone lines transmitting the one-second GPS data back to the Dublin server goes down and the GPS receiver needs to be accessed, this can now be achieved over the GSM communications link.

3.4 Security

During the development of the active GPS network there was a requirement to handle secure communications with Extranet Devices. In order to facilitate this it was decided by OSi to implement an additional DMZ on the existing OSi PIX Firewall. This new zone is referred to as the Extranet DMZ. This DMZ hosts the services required for the GPS project and controls access to and from the Internet DMZ. Figure 5 below illustrates the current infrastructure.

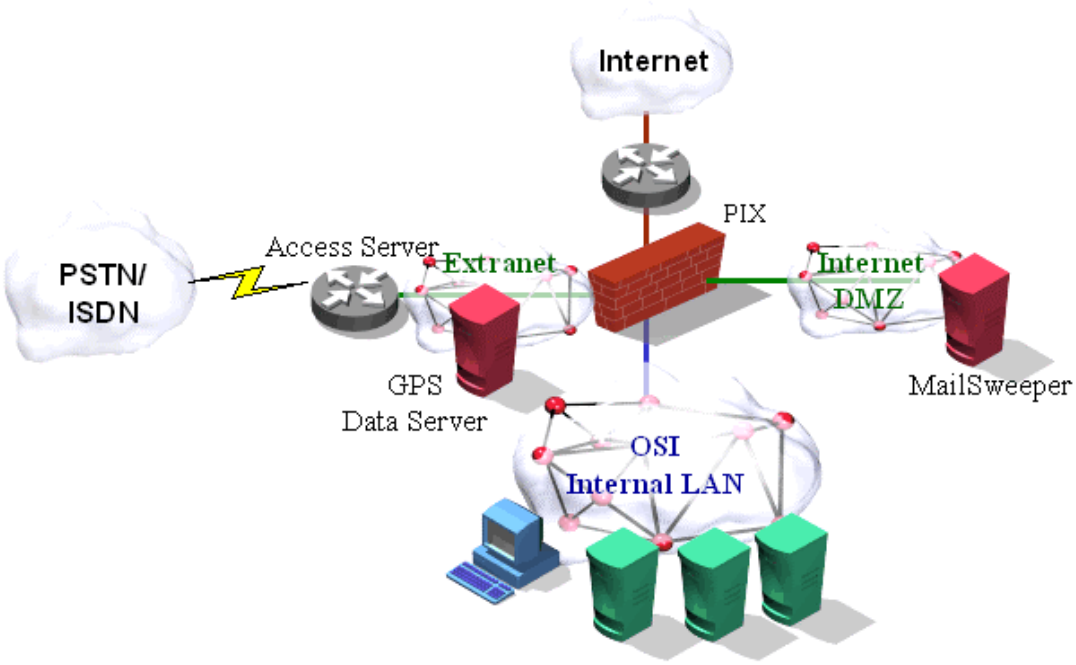

Figure 5: Internet and Extranet DMZ

3.5 Geodetic Reference Framework

During 2002 a GPS observation campaign was carried out to coordinate the centres of the GPS antennae to EUREF Zero Class B specification (better than two centimetres in X, Y, Z) and to ensure consistency with the pre-existing Class B specification stations in Ireland. The observation campaign was designed and computed under contract by the IESSG at the University of Nottingham and provided a high level of confidence in the computed coordinates of the stations.

4. IMPORTANT LESSONS LEARNED

4.1 Suitable Site Selection

During the implementation of the initial active GPS network important time was spent on the identification of suitable sites for the GPS antennae and receivers. Aside from the GPS requirement for open skies and minimum local obstacle interference, the main factors for site selection were security, electricity supply, existing telephone lines, and ease of access for on-going maintenance of the equipment. Typically the best sites enable the GPS cabinet (containing receiver, modem, UPS, and fan) to be installed within a lift-shaft housing near the roof, providing a short distance between the receiver and the antenna. It was also important that a good relationship was formed from an early stage with the relevant Building Services Manager in order that he or she had a good understanding of the importance of the equipment and of the possible need to gain timely access in the event of a system fault.

4.2 Network Stability Comes from Stable Communications

In the roll out and testing of the realtime network solution it was found that the stability of the positioning service was related to communications infrastructure and not the GPS equipment. It is very important to have a reliable communications infrastructure with built in redundancy in the event of system problems. From the experience during network testing, it was decided to install a GSM communications network between OSi Headquarters and each of the active GPS receivers. This enabled initial investigation and maintenance of the receivers to be carried out remotely in the event of a fault with PSTN phone lines. This has proven to be very beneficial in reducing both the amount of network downtime and maintenance travel time.

5. FUTURE DEVELOPMENTS

An imminent development of the Network RTK solution will be the strengthening of the network in the midlands by the installation of another active GPS station to provide redundancy in the realtime solution. This will be achieved by decommissioning one of the four Dublin active stations which is now surplus to requirements and re-installing it at a suitable location near the existing midland station in Athlone.

A second development of the solution will involve the inclusion of the three Ordnance Survey of Northern Ireland active GPS stations in the RTK network, thereby increasing the coverage of the realtime positioning service to cover Northern Ireland and the North West of

the Republic of Ireland. This will be achieved by in installation of a broadband communications link between the Network RTK GPS server in OSi Headquarters in Dublin and the Ordnance Survey of Northern Ireland GPS server in Belfast. One-second data will streamed from the three stations to the GPS server in Dublin and the required GPS corrections will be sent back to the GPS server in Belfast where they can be accessed by users in Northern Ireland.

The third development planned will involve strengthening the solution coverage on the West coast of Ireland by re-locating two additional active GPS stations from the Dublin area which are also now currently surplus to requirements. This development will be planned to coincide with the strengthening of the GSM mobile phone coverage in the same area. It is anticipated that these three developments will be completed by the end of 2004.

REFERENCES

Cory, M., Morgan, R., Bray, C. and Greenway, I., 2001, A new coordinate system for Ireland, Proceedings of the FIG Working Week, Seoul, available from www.fig.net

Morgan, R., Stewart, K., Bray, C. and Greenway, I., 2001, Making Ireland's national mapping compatible with users' technology, given at the RICS Geomatics Biennial Conference, Nottingham, September 2001

OSi, 2001, Developing Ireland's national mapping – an Information Paper, September 2001, available from www.osi.ie

BIOGRAPHICAL NOTES

Iain Greenway holds an M.A. in Engineering from Cambridge University, an M.Sc. in Land Survey from University College London and an MBA from Cranfield University (including study at Macquarie University, Australia). Between 1986 and 1999 he worked for the Ordnance Survey of Great Britain. His positions during those years included geodetic and topographic survey, strategic planning and pricing, sales and marketing, as well as a number of management consultancy inputs in Swaziland and Lesotho and technical consultancies supporting land reform in eastern Europe. In 1999-2000 he worked in Her Majesty's Treasury on improving public sector productivity in the UK. Since the summer of 2000, Iain has been Deputy Director of Ordnance Survey Ireland, responsible for much of the day-to-day management of a national mapping agency undergoing profound changes in status, structure, processes and culture. Iain is a Chartered Surveyor (MRICS) and a member of the Chartered Institute of Marketing (MCIM). He is the head of the RICS delegation to FIG, and Chair of the FIG Standards Network. He is also a member of the Management and Editorial Boards of the journal Survey Review.

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