Developing a National Real-time CORS Network in New Zealand

Dave COLLETT, New Zealand

Key words: GNSS, Positioning, CORS, New Zealand, Infrastructure

SUMMARY

Land Information New Zealand administers PositioNZ - New Zealand's national CORS network. This network consists of 33 permanent GNSS stations on mainland New Zealand. The primary purpose of this network has been to monitor regional earth deformation to enable the maintenance of the semi-dynamic New Zealand Geodetic Datum 2000. A secondary objective is to support the provision of traditional geodetic control by allowing users to download 30" RINEX data-files to process their data against.

In early 2009, LINZ commissioned an economic analysis to evaluate the national benefits of upgrading the communications to PositioNZ stations to enable the real-time delivery of this GNSS data. The brief also included looking at potential pricing options for this delivery. Due to the relatively low cost of upgrades, and the high potential public good, it was recommended that LINZ should make this data available to the public at no cost.

This paper discusses the findings of this economic analysis in more detail, and looks at how LINZ will develop the PositioNZ network to enable the national benefits identified to be realised.

Developing a National Real-time CORS Network in New Zealand

Dave COLLETT, New Zealand

1. INTRODUCTION

Land Information New Zealand (LINZ) is the New Zealand government department responsible for land titles and cadastral survey systems, topographic mapping, hydrographic charting, and the development and maintenance of the geodetic system.

LINZ's purpose as stated in its 2009/2012 Statement of Intent is to maintain and build confidence in property rights in land and geographic information, and encourage land information markets to develop and mature.

Since 2001, LINZ has been installing and operating the PositioNZ Continuously Operating GNSS Reference Station (CORS) network, in partnership with GNS Science (GNS). The network consists of 33 stations on mainland New Zealand (Fig 1), with an additional two on the Chatham Islands, and three in Antarctica. The network has a station spacing of 100-150km covering the whole of the New Zealand mainland.

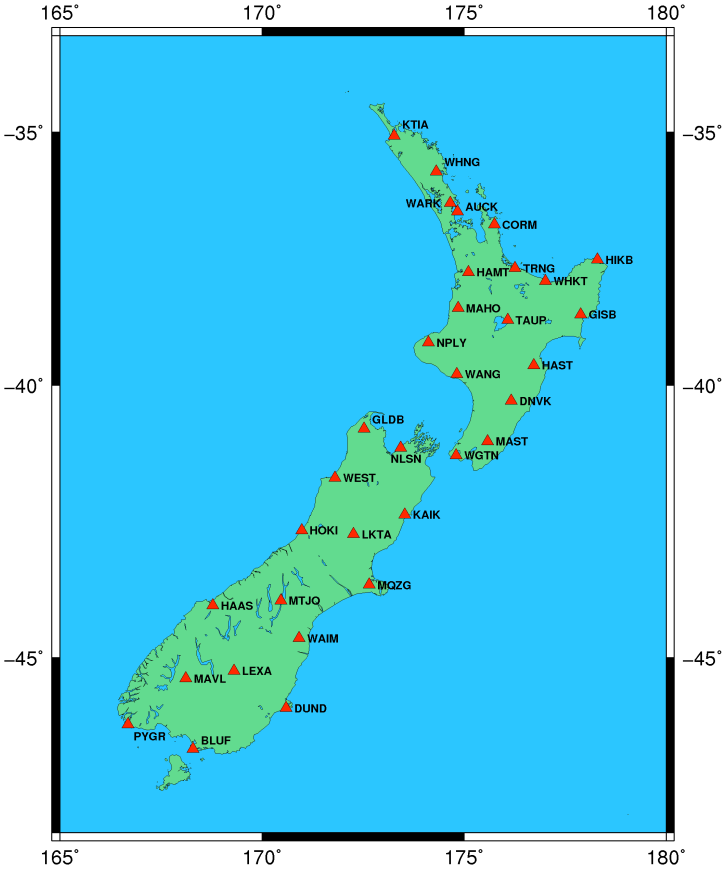

Figure 1-1: Current PositioNZ sites

The primary objective of the network is to monitor regional earth deformation, caused by plate tectonics, and their affect on the dynamics of New Zealand's official geodetic datum, New Zealand Geodetic Datum 2000 (NZGD2000). Secondary objectives of the network include supporting the provision of traditional geodetic control, and the provision of data for other users to obtain consistent positions in terms of NZGD2000.

The PositioNZ network is funded and administered in partnership with GNS Science and their GeoNet project (www.geonet.org.nz). As part of this partnership GeoNet contribute one third of the maintenance costs for each PositioNZ station, while LINZ pays all of the initial install costs for each station.

The GeoNet network currently consists of 100 CORS sites, which are distributed in areas of geohazard research, such as the Taupo Volcanic Zone (central North Island) and through the North Island tectonic shear belt (eastern North Island). These stations have a much denser spacing than the PositioNZ network- at around 30km (Fig 1-2).

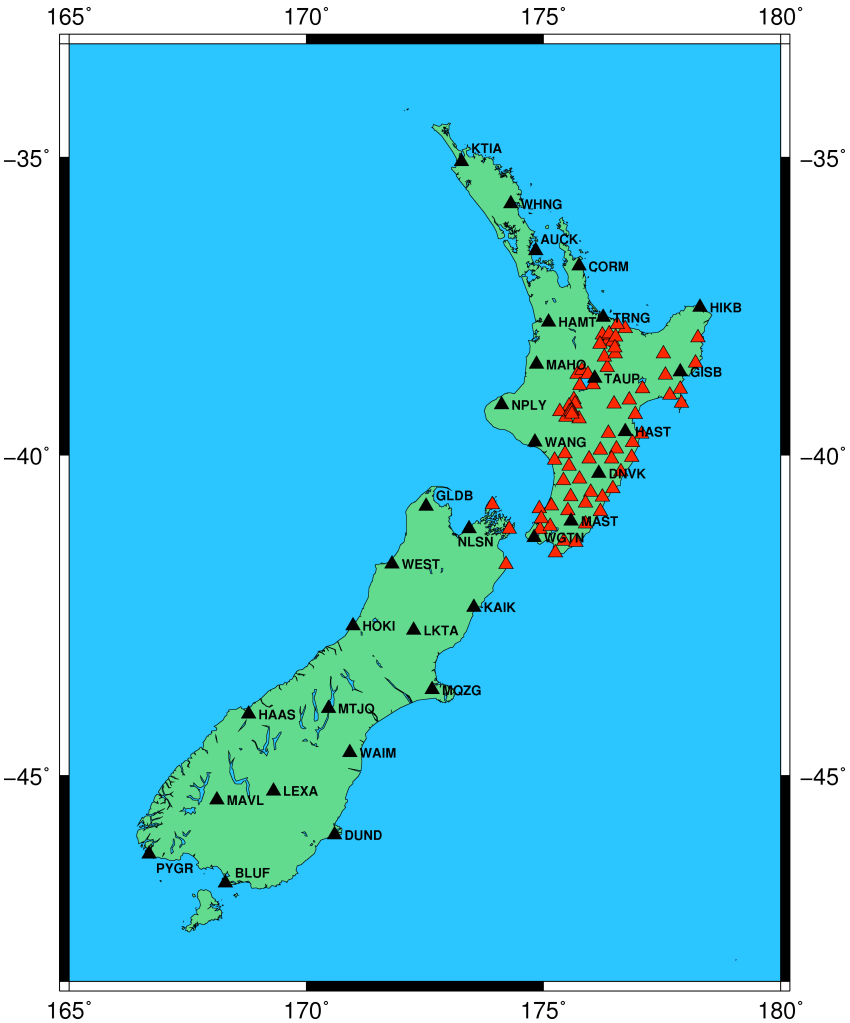

Figure 1-2: PositioNZ (black) and GeoNet (red) networks.

As part of the partnership, the maintenance of the network as well as all data management functions are carried out by GNS Science. Until recently, data has only been provided to the public as hourly and daily 30" RINEX files, available from the LINZ website (www.linz.govt.nz/positionz). Since 2006 LINZ has been trialling the streaming of 1" real-time data over the internet. This has been on a limited basis, to a small number of users, with no guarantee of continuity of service. There are currently 20 PositioNZ stations streaming data in this way. Due to the range of communications methods from the sites, the quality of these data streams varies considerably.

2. ECONOMIC ANALYSIS

The 2008 report "Economic benefits of high resolution positioning services", produced by the Allen Consulting Group for CRC-SI & Vic. DSE, showed that there are potentially significant benefits from precision positioning. This report found productivity gains with potential cumulative benefit of AUD$73B to $134B over next 20 years in agriculture, construction and mining alone using RTK techniques. It suggested that the national rollout of a standardised CORS network over Australia could generate an additional AUD$32B to $58B. Therefore, a large portion of the benefits of potential precision GNSS positioning can be attributed to a standardised national network. This is due to a reduction in duplication, and the promotion of greater and faster uptake of the technology.

Encouraged by this report, in early 2009 LINZ engaged the consultancy company McKenzie Podmore Ltd to investigate the economic benefits that can be expected to arise from the upgrading of the PositioNZ network to real-time status. An important component of this investigation was the pricing structure to be put in place should LINZ upgrade the network to real-time status.

The cost of upgrading the network to real-time status is largely the cost of upgrading the communications equipment at each site. It was estimated that such an upgrade would cost less than $NZD100,000 and an increase of around $10,000 in annual operating expenditure (which equates to an increase of around 4% on present operating costs.

It found that the "principal benefit from the LINZ network upgrade outside of its own use would be in reducing the need for third party commercial users to provide their own Real Time CORS stations at or near the same locations. The national economic benefit from avoiding this duplication of most of the present network resources is expected to exceed the costs of the upgrade in the ratio of twenty to one (ie the project has a B/C ratio of 20:1)."

The other major finding of the report was related to the issue of charging for the real-time data from the PositioNZ network. This network is managed and funded in partnership with GNS Science and their GeoNet network, the funding arrangement for which requires public access to the data free of charge. This would make charging for the data difficult, and in some cases counter to the GeoNet funding agreement. The costs of upgrade and ongoing delivery were

found to be small relative to the overall running costs of the network. As such, it was recommended that LINZ should not attempt to charge for the data.

Following the recommendations of this report, LINZ will be accelerating the upgrade of communications at these sites, and providing the data free of charge to all-comers.

3. CURRENT INFRASTRUCTURE AND PLANNED UPGRADES

The LINZ PositioNZ network (Fig 1-1) has a station spacing of 100-150km covering the whole of the New Zealand mainland. The communications infrastructure that was put in place as part of the initial development of the network was designed for the requirement of providing hourly and daily 30" RINEX files. This data is freely available through the LINZ website (www.linz.govt.nz/positionz) and can be used by members of the geospatial community to determine precise positions in terms of NZGD2000 when post-processed against a remote GNSS station.

For several years, LINZ has been streaming real-time 1" data from a subset of stations in the PositioNZ network in addition to the hourly 30" RINEX files. The stations selected for this trial were ones whose communication technologies were of sufficient reliability and latencies sufficiently low to be of use to 3rd party users. The use of this data was piloted by selected users, some of whom used it for single-base RTK corrections, while others combined the data with their own stations to generate Network-RTK solutions. (Blick et al, 2008)

Many stations in the PositioNZ network are quite distant from urban centres. This is due in part to New Zealand's low population density and the national coverage of the network. This means that the stations are often also distant from broadband internet connections to transfer the GNSS data to a data management centre for dissemination to the public.

Around a third of the PositioNZ network relies on VSAT (Very Small Aperature Terminal) satellite communications to transmit data to a data management centre at GNS where it is then made available over the internet. VSAT was chosen as the most reliable means of communication from these often remote sites. The VSAT communications have an inherent issue of latency, as it takes time for the signal to travel to the satellite and back to earth. Until recently the bandwidth from these sites was limited, so regular outages or high latencies were experienced if the GNSS data was sharing the communications with seismic installations at the site.

Following the strong indication of the benefits of moving PositioNZ to real-time status from the economic analysis, LINZ has committed funding to undertake communications infrastructure upgrades to increase reliability and decrease latencies. A priority list for upgrades was determined following consultation with the private sector. Upgrades of the VSAT system used have resulted in more complete data-streams from these sites. Improvement is due to extra bandwidth being available, so there is less conflict between the GNSS data streams and hourly file downloads at these sites. However, as the latencies are still an issue, alternative communication technologies will need to be investigated.

Many stations in the PositioNZ network use Freewave radio communication to transfer the data to a broadband internet connection. In some cases these links suffer from interference-especially in populated areas, which causes reliability issues with the streams. It is hoped that a move to licensed radio links will alleviate some of these problems. Other communications technologies such as Wi-Fi and cellular links are also being investigated.

Real-time 1" data is currently being streamed from 20 PositioNZ stations (Fig 3-1) including one on the Chatham Islands. Access to these streams has been widened, and connection details will be posted on the LINZ website shortly. Upgrades currently underway will leave only 3 stations to be upgraded to streaming status. These tend to have long radio links, or other problems such as lack of broadband internet availability which make reliable streaming difficult.

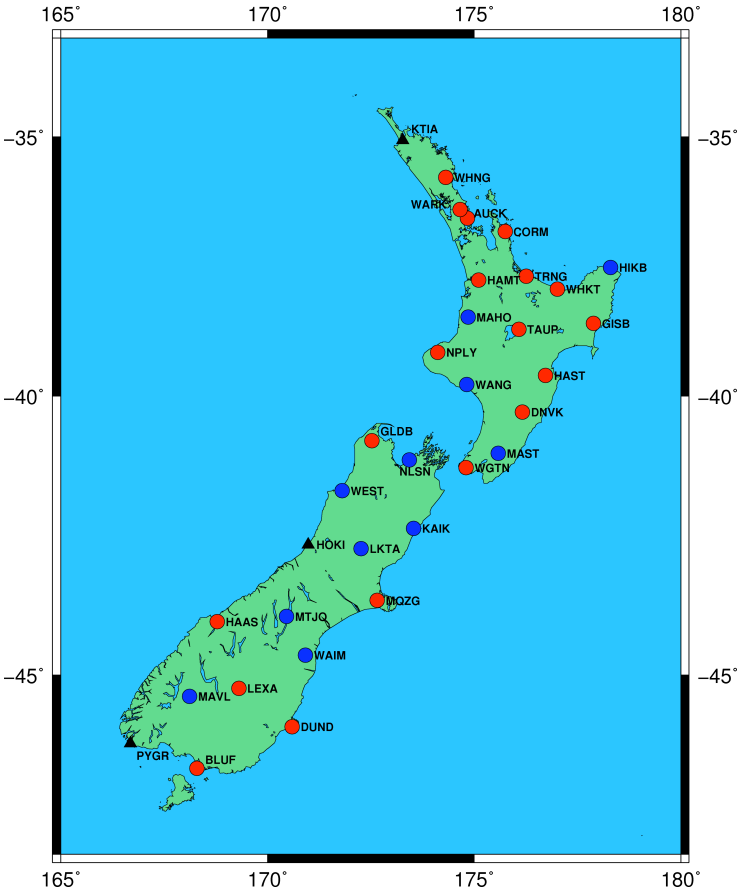

Figure 3-1: PositioNZ currently streaming sites (red) and priority upgrades (blue).

The other key factor affecting usability of the current PositioNZ real-time 1" data streams is the lack of support of satellite systems other than GPS. Due to this, LINZ will be upgrading the whole of the PositioNZ network to GNSS receivers from July 2010. It is hoped that a large majority of the network will be GNSS-capable within 12 months of beginning these upgrades.

4. DEVELOPING A NATIONAL CORS NETWORK

The inter-station spacing of the PositioNZ network means that the vast majority of New Zealand cannot be serviced by single-base RTK corrections from these stations. Neither does the network meet the industry standard spacing for Network-RTK solutions of around 70km.

GNS Science have indicated that the GeoNet network will be gradually upgraded to real-time status, and that it will be a consideration for new installations. PositioNZ, combined with this upgraded GeoNet network, will provide a substantial underlying national infrastructure of CORS supplying real-time GNSS data free of charge to the geospatial community and the wider public.

LINZ has been engaging with external stakeholders in this market, predominantly private companies Global Survey and GeoSystems, who operate 20 of their own stations between them. Their infrastructure is used to provide a commercial service to customers- usually in the form of single-RTK corrections, or sometimes as Network-RTK corrections in conjunction with PositioNZ streams. These private stations have usually been installed specifically with commercial real-time data provision in mind, and as such the streams perform with a much higher level of reliability. These stations are directly connected to broadband internet connections meaning they have fewer outages and lower latencies which can be caused by satellite and radio communications.

The provision of Network-RTK is not seen as the role of LINZ, however part of its purpose is to encourage land information markets to develop and mature. Therefore, LINZ is working to support the development of such networks, and is keen to develop interoperability and consistency between them.

One way to do this is to assign official NZGD2000 coordinates to these stations to encourage consistency of coordinates. LINZ allows CORS operators to submit the results of a geodetic survey connecting their stations to local geodetic control. This is then used to generate an accurate coordinate for their station, which is loaded into the authoritative geodetic database. They must also provide details of the site and photographs to assure LINZ that the station is constructed to a standard expected of a geodetic mark. It is accepted that the monumentation used for a commercial CORS site does not need to be of the same quality as a geodetic installation such as a PositioNZ station which requires connection to the bedrock. LINZ recommends that commercial providers comply with the Guidelines for New and Existing Continuously Operating Reference Stations (CORS) produced by the National Geodetic Survey (NGS). So far only one such station has been submitted for inclusion.

5. CONCLUSIONS

Land Information New Zealand has committed to upgrading its national CORS network - PositioNZ to provide real-time 1” GNSS data to users free of charge. This is following an economic analysis undertaken by an independent consultant which estimates that the upgrade

would have a benefit/cost ratio of 20:1. LINZ will also start upgrading the entire PositioNZ network to GNSS capable receivers from July 2010.

It is hoped that PositioNZ will form the underlying infrastructure which will be in-filled with GNS stations and by commercial users who will combine the data with that of their own stations to provide value-added services such as Network-RTK. Additionally, these commercial users are able to submit their stations for inclusion in the geodetic system with an official NZGD2000 coordinate- a useful addition for their customers.

REFERENCES

Allens Consulting Group for CRC-SI & Vic. DSE, 2008, "Economic benefits of high resolution positioning services"
http://www.crcsi.com.au/UPLOADS/PUBLICATIONS/PUBLICATION_348.pdf

Blick G, N Donnelly, D Collett, A Jordan, 2008, "Future Development of the New Zealand GNSS Continuously Operating Reference System - PositioNZ", FIG Working Week 2008

GNS Science, for Land Information New Zealand, 2009, "Status of 1 second GPS data streams from prioritised PositioNZ sites"

Land Information New Zealand, 2009, "Land Information New Zealand Statement of Intent 2009/2012"

McKenzie Podmore Ltd for Land Information New Zealand, 2009, "Economic Issues Regarding LINZ Conversion of its Precision Reference Network to Real Time Status"
http://www.linz.govt.nz/docs/surveysystem/geodetic/cors-upgrade-economics-report.pdf

National Geodetic Survey, 2006, "Guidelines for New and Existing Continuously Operating Reference Stations (CORS)"
http://www.ngs.noaa.gov/PUBS_LIB/CORS_guidelines.pdf

BIOGRAPHICAL NOTES

Dave Collett, BSurv(Hons) (Otago). Dave has worked as a Geodetic Surveyor at LINZ for 4 years since graduating from the University of Otago. His areas of interest include the management and development of the PositioNZ network, and Antarctic Mapping.

CONTACTS

Mr Dave Collett
Land Information New Zealand
PO Box 5501
Wellington 6145
NEW ZEALAND
Tel. + 64 4 4600551
Fax + 64 4 4983837
Email: dcollett@linz.govt.nz
Web site: www.linz.govt.nz