New Zealand geodetic system Part 4 – PositioNZ GNSS continuously operating network

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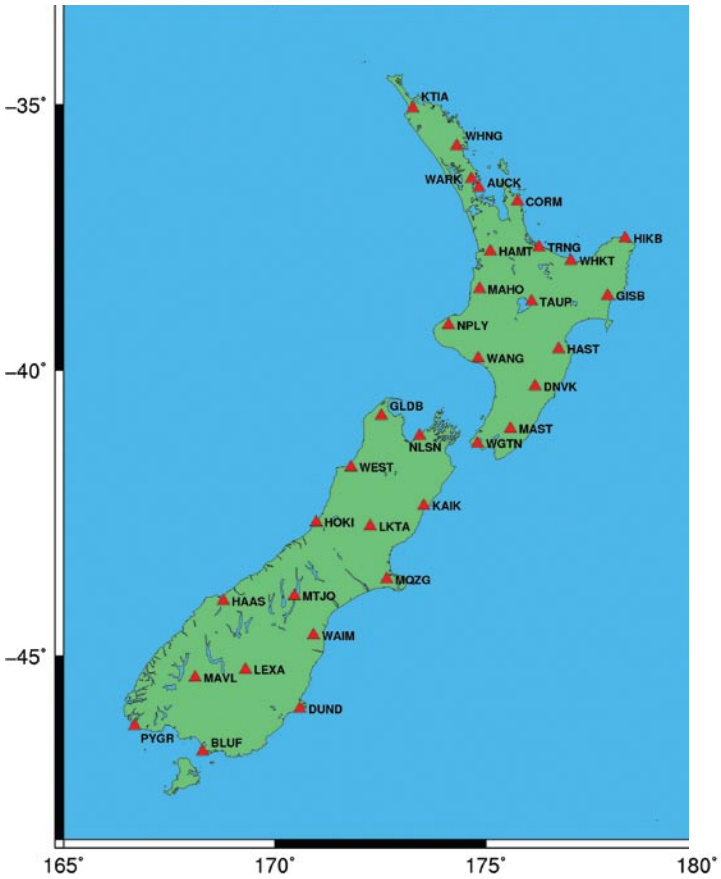
A fundamental component of any modern geodetic system is a Global Navigation Satellite System (GNSS) Continuously Operating Reference Station (CORS) network. In New Zealand, LINZ operates the PositioNZ network, principally established to monitor the New Zealand Geodetic Datum 2000 (NZGD2000). More recently it has been recognised as contributing to New Zealand's geospatial infrastructure. In this, part four of a series of articles on New Zealand's geodetic system, we describe the PositioNZ network and its functions, and propose a model for a national CORS network that incorporates both public and private CORS stations.

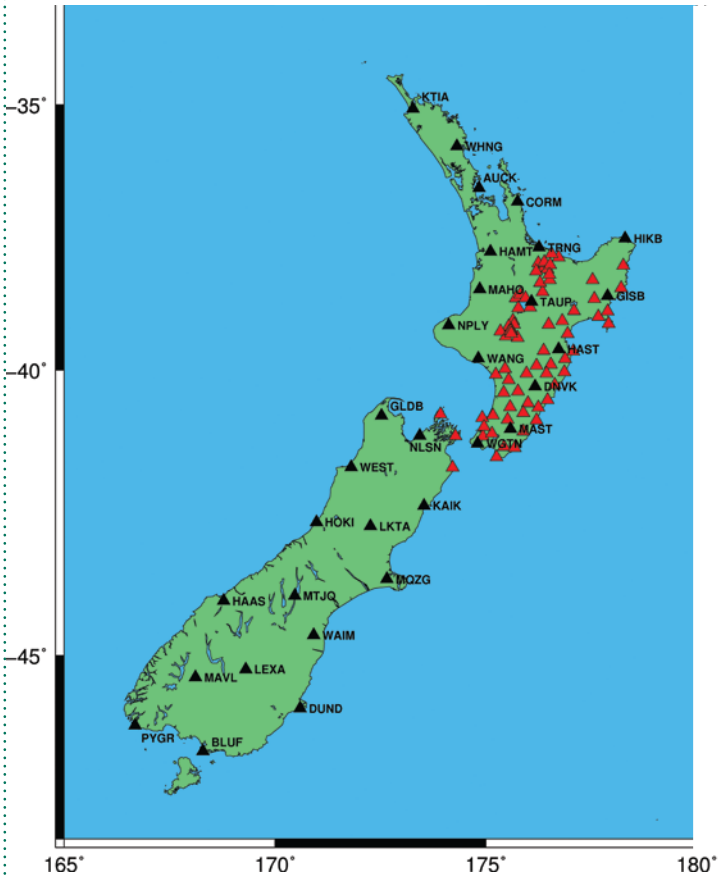
PositioNZ network

Since 2001, LINZ has been installing and operating the PositioNZ CORS network, in partnership with GNS Science. The network consists of 33 stations on mainland New Zealand, with an additional two on the Chatham Islands and three in Antarctica. The network has a station spacing of 100 to 150 km, covering the whole of the New Zealand mainland.

The primary objective of the network is to monitor regional earth deformation, caused by plate tectonics, and its effect on the dynamics of NZGD2000. Secondary objectives of the network include supporting the provision of traditional geodetic control, and



Current PositioNZ sites.



PositioNZ (black) and GeoNet (red) networks.

the provision of data for other users to obtain consistent positions in terms of NZGD2000.

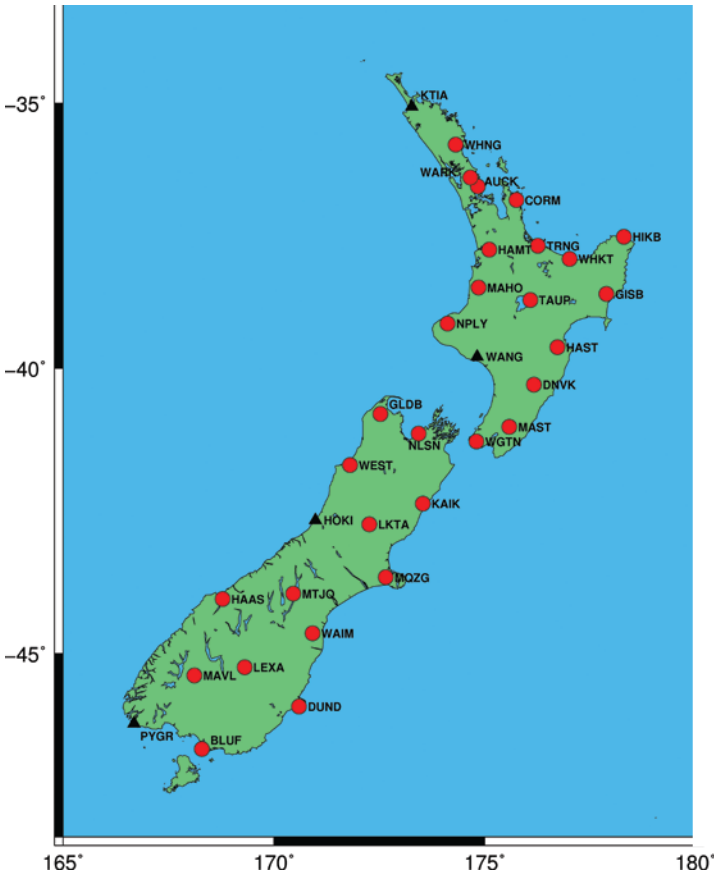
The PositioNZ network is funded and administered in partnership with GNS Science and its GeoNet project www.geonet.org.nz. The GeoNet network currently consists of 100 CORS sites, which are distributed in areas of geo-hazard research, such as the Taupo volcanic zone in central North Island and through the North Island tectonic shear belt in eastern North Island. At around 30 km, these stations have a much denser spacing than the PositioNZ network.

PositioNZ network upgrades

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. A total of 20 PositioNZ stations are currently streaming data in this way. Due to the range of communications methods from the sites, the quality of these data streams varies considerably.

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. It means stations are often also distant from broadband internet connections to transfer the GNSS data to a data management centre for dissemination to the public.

In 2008, LINZ commissioned a report to investigate the expected economic benefits from upgrading of the PositioNZ network to real-time status. 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 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).'



PositioNZ streaming sites (red) and priority upgrades (blue).

Following this strong indication of the benefits of moving PositioNZ to real-time status, 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.

Real-time 1" data is currently being streamed from all but four mainland NZ PositioNZ stations as well as one on the Chatham Islands. Connection details are available on the LINZ website. Upgrades currently under way should see the remaining stations upgraded to streaming status by mid-2011. These tend to have long radio links, or other problems such as lack of broadband internet availability, which make reliable streaming difficult.

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. Consequently, LINZ is currently undertaking an upgrade of the entire PositioNZ network to GNSS receivers. It is expected that the entire network will be GNSS-capable by mid-2011.

PositioNZ-PP

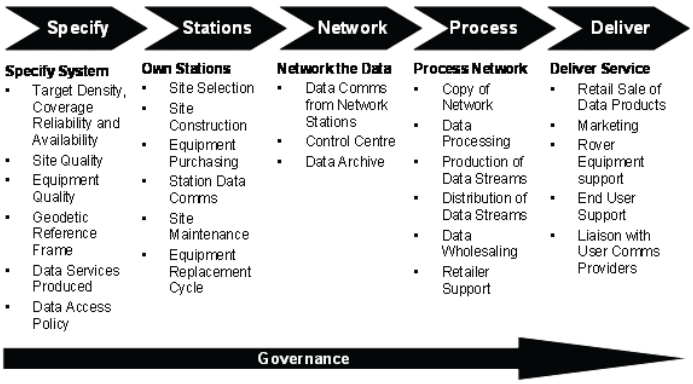
A further development of PositioNZ is the development of a GNSS post-processing service, PositioNZ-PP. This is similar to an Australia system called AUSPOS www.ga.gov.au/geodesy/sgc/wwwgps/. PositioNZ-PP is being developed in conjunction with Geoscience Australia as it upgrades its AUSPOS system.

Such a service allows users to submit dual frequency, geodetic quality GNSS data via the internet to calculate precise NZGD2000 coordinates. It requires users to submit GPS (RINEX) data observed in a static mode for precise coordinate results. The service uses IGS (International Global Navigation Satellite System Service) products and GPS network data to achieve precise solutions globally. A full description of PositioNZ-PP is provided by Palmer.

Model for a unified CORS network

In developing a unified national CORS network for New Zealand, it is useful to consider a model that includes both public and private organisational involvement. Higgins proposes such a model. The model breaks the process into six discrete roles that a particular organisation might play.

- **Specify system**. The organisation(s) that specify the characteristics of the reference station networks such as station density, and quality of mark and equipment.

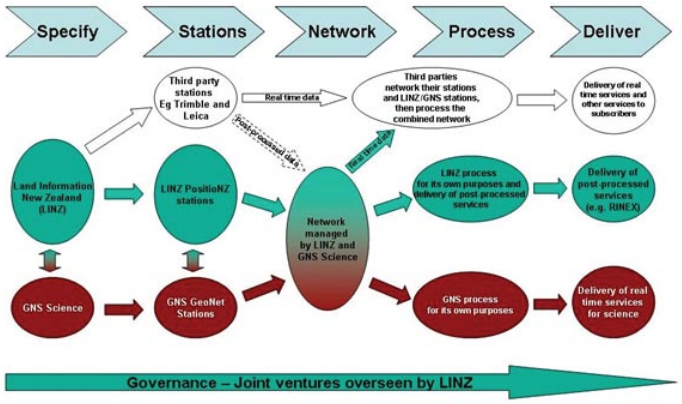


A model for describing organisational roles in precise positioning services.

- **Own stations**. The organisation(s) that own the reference stations and are responsible for issues such as site selection, construction, maintenance and equipment.
- **Network the data**.The organisation(s) responsible for bringing the data together from the network into a central processing centre. This includes data communications and data archival.
- **Process network**. The organisation(s) responsible for data processing and includes production and distribution of data streams, and retailer support.
- **Deliver services**. The organisation(s) that are typically the retailer to end users. Their roles include delivery of data products and retailing of products, marketing and end user support.
- **Governance**. The organisation that provides clear governance mechanisms to enable all parties concerned to ensure coordination across all groups and give confidence to end users that the whole systems is reputable and can be relied on.

Unified CORS model for New Zealand

Applying the proposed organisation model described above to New Zealand shows different organisations playing various roles, some of which clearly already exist.



Applying the model to describe the situation in New Zealand.

LINZ and GNS Science have established a set of standards for the establishment of their core networks. These rely heavily on international IGS requirements. LINZ has also developed draft specifications for the establishment of third party sites so that they can be included as part of the national geodetic framework.

Stations have been installed and are managed by the public sector – LINZ and GNS Science, and the private sector such as Trimble and Leica.

The PositioNZ and GeoNet networks are managed collectively as one network by GNS Science. Third party agencies typically manage their own networks and are being encouraged to supply data through to the public network, so that data may be used for datum monitoring, hazard mitigation and disaster recovery. Raw data from the PositioNZ/GeoNet network is freely available to third parties for their use.

Typically, each agency processes data to meet its own needs. LINZ's PositioNZ data is used for datum monitoring and is distributed for wider geospatial uses as part of a core geospatial infrastructure. GNS Science's GeoNet data is used for hazard monitoring and science applications and has also been recognised as part of a geospatial infrastructure. Third parties may include data from the PositioNZ/GeoNet network with their data to meet their or their customers' needs. Delivery of the data is specific to the requirements of each agency. This may include sale of data and services to clients, or the integration with other data and the provision of hazard estimations and warnings.

Under the model described it is proposed that governance of such a system would be overseen by LINZ. In assuming this role, LINZ is working with third-party and other government agencies to coordinate efforts to develop a single national CORS network.

Under the model described here, there are clear roles for the public and private sectors.

The role of the public sector is to –

- Maintain the datum – refine and define the NZGD2000 deformation model
- Monitor stability of CORS, unify different CORS networks – provide accreditation for 3rd party CORS
- Provide support to international reference frames and projects (APREF, ITRF)
- Provide standards and specifications
- Provide a leadership and a coordinating role for development of a shared and partnered national CORS network
- Provide geo-hazard information and science outputs
- Provide static GNSS data and services – hourly RINEX files, PositioNZ pp
- Provide raw GNSS real time data streams (bulk data)
- Encourage 'industry development' through precise positioning applications, services and products
- Stay out of the service market

The role of the private sector is to –

- Use publicly funded GNSS data and add value to it
- Provide network and real time services to clients
- Provide training
- Provide 'near' real time and static data to Government for hazard recovery, research and datum monitoring

Summary

LINZ continues to maintain and upgrade the PositioNZ CORS network in New Zealand. Current developments include the provision of real time 1" data, upgrade of the network to GNSS, and development of a post-processing service.

LINZ is also encouraging the development of a unified CORS network for New Zealand involving a partnership between the public and private sectors. Such a partnership would enable increased public value from the publicly funded CORS networks and enable GNSS data to be collected once but used many times for different purposes. It would also enable the private sector to contribute to Government outcomes, such as datum monitoring, hazard monitoring, and disaster recovery. Under such a partnership, however, public and private parties will have clear roles.

References

Palmer, J. 2010: PositioNZ-PP - A GPS Post-Processing Service for New Zealand. *Proceedings of the XXIV FIG International Congress 2010.*

Higgins, M. B. 2008: An organizational model for an unified GNSS reference station network for Australia. *Journal of Spatial Science Vol. 53, No. 2, December 2008*